DOCUMENT RESUME

ED 225 708 RC 013 747

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TITLE	Linking Outdoor School with the Home Environment. A Follow-Up Resource Guide for Teachers.
INSTITUTION	Multnomah Outdoor Education, Portland, Ore.
PUB DATE	Aug 81
NOTE	156p.; For related documents, see RC 013 748-752 and ED 175 590-594. Field Test Copy. Maps may not reproduce well.
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC07 Plus Postage.
DESCRIPTORS	Conservation (Environment); *Environmental Education; Environmental Influences; Experiential Learning; Followup Studies; Grade 6; Intermediate Grades; Land Use; *Learning Activities; *Natural Resources; *Outdoor Education; Photosynthesis, Plant Growth; Pollution; Resident Camp Programs; Resource Materials; Soil Science; Solar Radiation; *Urban Environment; Water Resources; *Wildlife
IDENTIFIERS	*Multnomah County Outdoor School OR

ABSTRACT

A source of ideas and direction for follow-up to the Multnomah County Outdoor School program, the guide identifies concepts generally common to all outdoor school sites from year to year: the water cycle; watershed; water as a habitat for plants and animals, an oxygen supplier, and a producer of usable power; sun energy; plants as producers and decomposers in the ecosystem; plants' economic value; conservation, preservation and utilization of the plant resource; sunlight, soil, and moisture; plant succession and classification; animal populations and habitats; introduction or removal of a species from a habitat; energy pyramid and cycle; factors affecting soil; soil composition; man's effect on erosion and wildlife; soil minerals and nutrients; and soil as a renewable resource. How each concept can be understood both at and after the outdoor school is briefly discussed. Each concept is followed by a section listing goals, key words, films, and review discussion topics and questions which can be used after returning to the community to link the outdoor school with the students' home environment. Activities, experiments, comparisons, and observations which can be accomplished in the school environment are suggested. The guide concludes with 30 questions commonly used to measure environmental impact on a "sophisticated and professional" level. (NQA)

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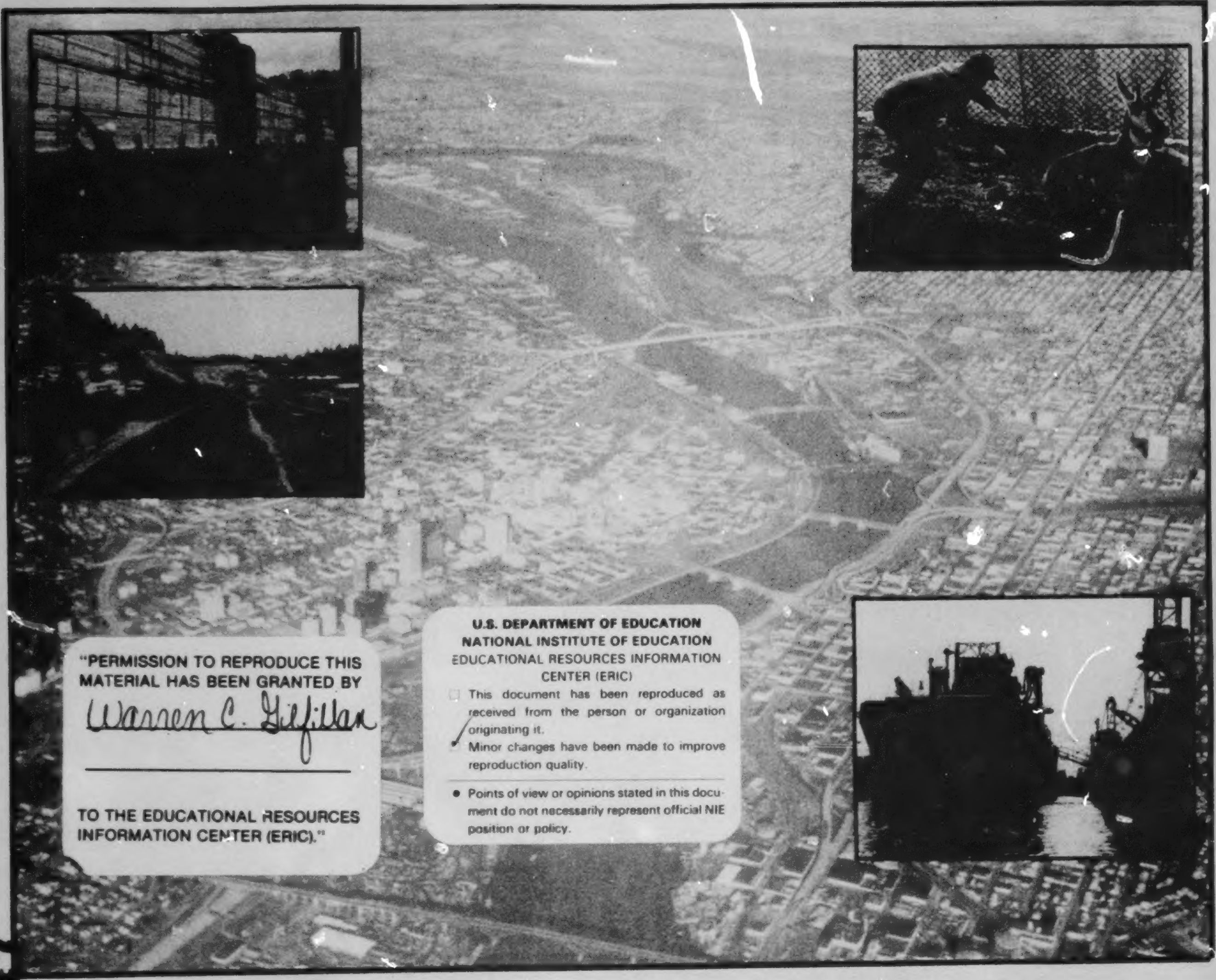
LINKING OUTDOOR SCHOOL with THE HOME ENVIRONMENT



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RC013747

A FOLLOW-UP RESOURCE GUIDE FOR TEACHERS

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FIELD TEST COPY

LINKING OUTDOOR SCHOOL WITH THE HOME ENVIRONMENT

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With Special Thanks To:

Kay Tomich, Typist

AUGUST 1981

Teachers:

This guide is a source of ideas and direction for follow-up to the Multnomah County Outdoor School program. Although there are differences between Outdoor School staffs and site conditions, the concepts developed in this guide are identified as ones generally common to all Outdoor School sites from year to year. Although these concepts can be most easily understood in the natural environment, they gain special significance to students who see how these subjects pertain to their own lives.

One of the purposes of Outdoor School is to provide a foundation which will later help your students understand the complexities of their urban environment. After returning to the community, you may use films, guest speakers, consultants, and this guide to help your students understand how concepts dealing with natural systems are important in their daily lives. Some of the following activities suggest experiments, comparisons, and observations which take a long time to complete. This is an impossibility during one week at Outdoor School, but can be accomplished easily in the school environment.

Because of possible time limitations due to spring Outdoor School attendance please feel free to pass this guide along to a 7th grade teacher who could also conduct follow-up activities. Additional books are available for other teachers involved in departmental teaching.

Since this is a first run, field test copy, your comments, suggestions, and contributions are essential for developing the finished product.

CONCEPT

There is a broad cycle of water movement from the atmosphere to the land and the seas and back to the atmosphere.

AT OUTDOOR SCHOOL

Students on the site are seeing an important segment of the water cycle. Rainfall on or near the Outdoor School may be easily observed entering the stream from the soil surface....which is described as direct runoff. Most rainfall percolates through the soil, into the water table and part may pass the students by way of the stream. The surface of the stream generally represents the level of the adjacent water table. They also understand that the stream does not remove all the water from the area....a large quantity is transpired and evaporated back to the atmosphere. Water also percolates slowly to the aquifers far underground. The quantity of water in the stream is affected by weather, geography, soil type and plant cover. Students can understand that the management and use of the land and the stream affects the quantity and quality of the streamflow. It is also vital that students realize the unpredictable, unstoppable force of the stream and control of the stream is sometimes only temporary. Man can slow down or divert the flow, but during certain conditions, this flow defies the best of engineering and management.

AFTER OUTDOOR SCHOOL

Generally students should understand why the rainfall Oregon receives is vital to the prosperity of the area....keeping Oregon both green and clean. By using maps and rainfall records, students can see how the proximity of the ocean, the Coast Range, Cascade Range, and other factors affect the water cycle. Students should understand how, when, and where pollution enters the water cycle, and how they, as part of the Portland population, affect pollution. Students can understand how man's use of water has complicated the path the water must take on its way to the ocean. Concerning this use, it will be interesting for your students to learn what methods have been developed to return water to the natural system.

CONCEPT

A watershed is a drainage region that supplies water to the lakes, streams, and ground water within it.

AT OUTDOOR SCHOOL

Students realize that the Outdoor School site is part of the Columbia River watershed and that this large area is made up of thousands of smaller watersheds. Although any land area is part of a watershed, this term is commonly used to denote an area drained by one stream that supplies water to a populated area or for a specific purpose. Students know that Portland's water comes from the Bull Run watershed. (Deep wells, now being planned to be dug east of the Portland airport, will someday supplement this supply.) Students at the Howard Outdoor School site are fortunate enough to actually observe the Bull Run watershed. However, students at all the sites can understand the environmental factors that affect such a watershed. They learn how precipitation usually percolates through the soil and becomes visible again as it emerges in a lake or stream within the watershed. The amount and kind of vegetation, soil type, slope, and geology of the area are all factors that affect the quantity and quality of the water. Students may also see how surface runoff (to a stream) can speed up the time between when precipitation enters the watershed and when the water eventually enters a reservoir. This surface runoff can cause siltation and erosion. At Outdoor School, students observe how good ground cover can regulate this flow. This flow is measured in cubic feet per second in a stream and can be converted to gallon-output per day. Knowing the amount required to sustain our way of life, your students can understand that the stream can support only a limited number of people.

AFTER OUTDOOR SCHOOL

After observation and study of watersheds in the field, students can now begin to learn how Portland's watershed relates to their everyday lives. How the water gets from the watershed to Portland, how it is used, and how much is used all become concerns to us once we understand the source of our water. Since the quantity from this source is limited, our goal is understanding the necessity of conservation and learning practical methods of conserving in the home school and community.

The management of watersheds is highly controversial because of man's vital daily dependence on water and the many land use conflicts created by man himself. Although this subject is complicated, many of the natural effects can be basicly understood.

The watershed lesson then, is especially important because it ties together many of the goals in both soil and plant study.

LINKING OUTDOOR SCHOOL WITH THE HOME ENVIRONMENT

GOALS

In reviewing the basics of the water system, students can begin to understand the magnitude of supplying water to a large metropolitan area. The next time one turns on a faucet and then watches the water disappear down the sink, one should not only get a mental image of the source of the water and the link to the natural system, but also should imagine the basic components of the system. Our daily dependence and affect on water necessitates this.

Students should be able to:

- Describe how mountains and other land forms affect rainfall.
- Understand the basics of supply, use, reuse and disposal of our water.
- Relate marine air, humidity, wind direction, and dew point to the water cycle.
- Trace water from the Outdoor School back to the site when there is no effect from man.
- Trace water from the Bull Run Watershed to the Pacific when there is heavy use in the Portland area.
- Compare the water cycle involving the Bull Run Watershed with an unmanaged watershed.
- Trace water falling on your school roof to the ocean.
- List various kinds of pollutants carried by water. List ways pollution enters the water cycle.
- Explain why there are variations in water supply.

KEY WORDS

Evaporation
Condensation
Convection
Runoff
Percolation
Water Table
Ground Water
Transpiration
Pollution (point/non-point)
Humidity
Dew Point
Aquifer
Watershed
Sanitary Sewer
Storm Sewer
Cubic Feet Per Second

MULTNOMAH COUNTY E.S.D. FILMS

Water Cycle

Conserving Our Water Resources - #41011
Water Pollution: A First Film - #41550
Water...The Common Necessity - #42180
Water's Running - #40120

Watershed

Birth Of A River - #41022
Water Purification - #40751

REVIEW DISCUSSION TOPICS AND QUESTIONS

What role does the ocean and our geography play in our rainfall?

How much rainfall do we receive? How do we measure it? Why is it important? How many gallons will we receive on the school yard? Where does it go?

What is pollution? Where does it enter the system? How do we remove it?

How many gallons do we use daily? How many gallons do we use considering the production of food, machines, etc. in our daily lives?

What role do plants play in the water cycle?

What role do different soil types play in the water cycle?

Compare the urban water cycle to the natural water cycle.

What was the amount of water flow at the Outdoor School? How was it measured? How many people could live by that stream?

What are some of the basic water problems that occur in our natural world? (Floods, irregular supplies....shortages, natural poor quality.)

BACKGROUND INFORMATION

Average Rainfall

Portland - 42"/year
Adams - 50"/year
Collins - 54"/year
Arrah Wanna - 70"/year
Colton - 50"/year
Howard - 68"/year

USES OF WATER

60 gallons per day used per person in this country.

1,500 gallons used per day per person when considering manufacture or production of products and foods used daily.

100,000 gallons for production of a car.

65,000 gallons used for one ton of paper pulp.

2½ gallons for production of a phonograph record.

6,000 gallons to produce one bushel of corn.

60 gallons to produce one pound of wheat.

200 gallons to produce one pound of rice.

200,000 gallons to produce one ton of alfalfa hay.

2,500 + gallons to produce one pound of beef.

1,000 gallons to produce one quart of cow's milk.

150 gallons to produce one Sunday newspaper.

650 gallons to produce steel for one bicycle.

USES OF WATER (CONTINUED)

200 gallons to produce rubber for one tire.

300 gallons to produce 2.5 lbs. of bread.

770 gallons to refine 42 gallons of oil (1 barrel).

Over ½ of the fresh water used annually is for the irrigation of crops.

Household Use Of Water

Amount of water used for:

Bath	30 gallons
Shower	20 gallons
Toilet	3-5 gallons
Washing Hands	2 gallons
Washing Dishes	8 gallons
Cook Meal	5 gallons
Clothes Washer	32 gallons
Bathroom Faucet	2-5 gallons per minute

RECYCLE

60% less water to produce recycled paper.
70% less energy to produce recycled paper.
70% fewer pollutants produced when making recycled paper.

EVAPORATION AND TRANSPIRATION....RAINFALL....WHAT HAPPENS TO IT?

The annual evaporation of a typical ranch stock pond would equal what 500 cattle would drink.

74% is evaporated or transpired back to the atmosphere (this is an average national figure....taking in the affects of dry land conditions); 36% may be runoff (in the Northwest, water loss is closer to 50%).

One maple tree transpires 50 gallons per day.

One corn plant transpires 50 gallons during its growing period, or needs more water in a day than one adult.

One acre of corn transpires 325,000 gallons during its growing period.

Water yield can be increased or controlled by managing the amount and kind of vegetation.

POLLUTION

What is it? Pollution is anything that changes the quality of water from its source, i.e. at the point of evaporation from the oceans. Even at that point it could be polluted from dust or smoke in the air. But for this purpose let's say that it starts as rain as it falls on the earth. If it mixes with soil as in splash erosion, we call it muddy water and we don't want to drink it as it looks "dirty", but it might not be harmful to drink. If it should mix with human or animal waste and pick up harmful bacteria, it might "look" clear, but not be fit for drinking. Most "clear" mountain streams are now in this condition. If water was exposed to toxic chemicals it could be "clear" but would probably make humans ill. On the other hand, people with swimming pools take pure water and add chemicals (chlorine) to it to prevent bacteria from developing and "polluting" the water. The fact is that almost all water from urban water systems is treated with chemicals (chlorine and ammonia) during certain "risk" periods or all of the time. One might say we "pollute" the water to prevent "pollution". It comes down to the fact that "pollution" is only as we humans perceive it and how it serves our needs. Even heat added to water can be "pollution".

One-half of all water pollution occurs during rain runoff. This is called non-point pollution as it picks up pollution from anywhere over a large area, not any single point. Point pollution is that which can be traced to one source and therefore can be more easily managed.

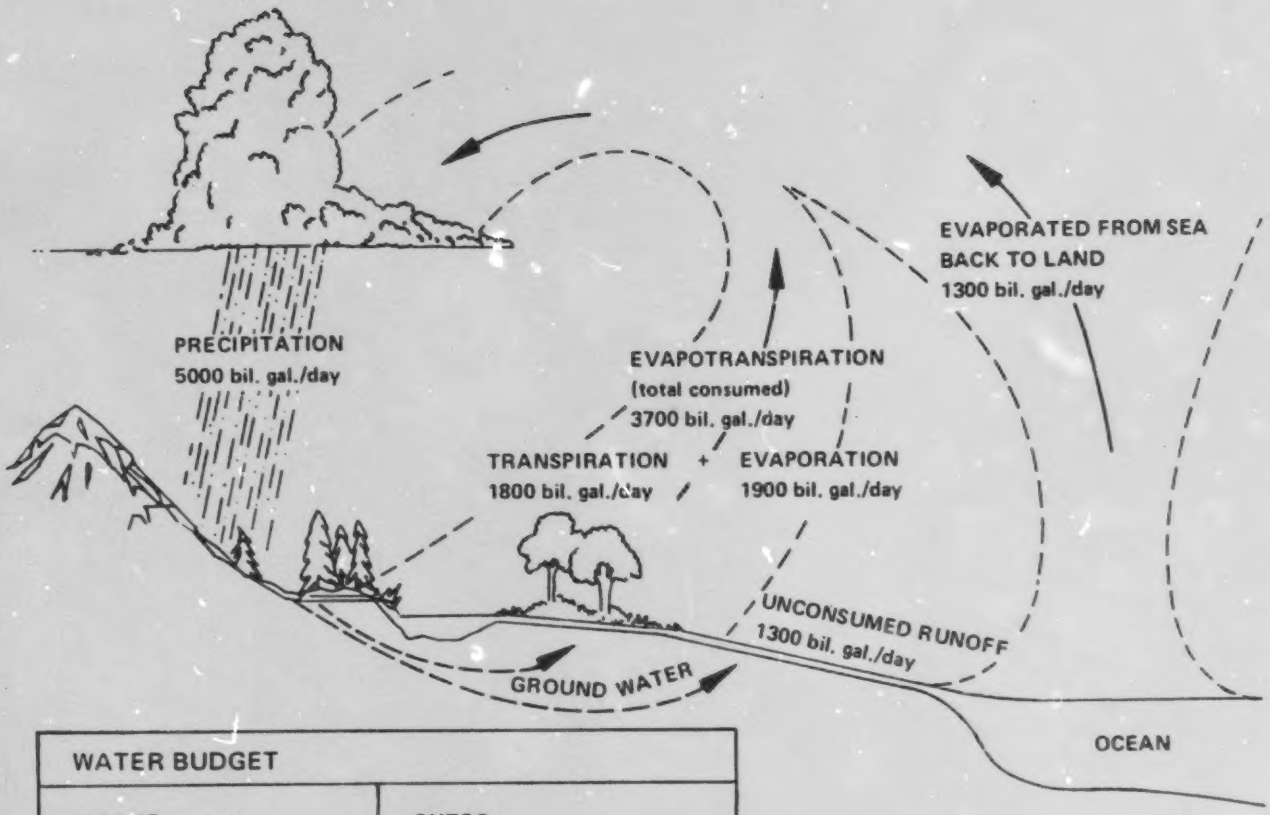
Three general sources of pollution....soil sediments, human organic waste, and industrial waste.

Pollution is generally:

1. Organic waste....from agriculture, industrial, and domestic sources.
2. Biological nutrients....which increase plant growth....eutrophication.
3. Disease bearing organisms.
4. Temperature increases.
5. Synthetic chemicals.

90-95% of our municipal water purification systems were originally designed to kill bacteria only....but cannot eliminate all toxic chemicals.

WATER BUDGET


PRECIPITATION
5000 bil. gal./day
EVAPOTRANSPIRATION
(total consumed)
3700 bil. gal./day
TRANSPIRATION
1800 bil. gal./day
+
EVAPORATION
1900 bil. gal./day
EVAPORATED FROM SEA
BACK TO LAND
1300 bil. gal./day
UNCONSUMED RUNOFF
1300 bil. gal./day
GROUND WATER
OCEAN

WATER BUDGET	
INCOME	OUTGO
from precipitation 5000 bg/d	Transpired 1800 bg/d Evaporated 1900 bg/d Total consumed 3700 bg/d Unconsumed runoff 1300 bg/d
TOTAL INCOME 5000 bg/d	TOTAL OUTGO 5000 bg/d

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WATERSHED DISCUSSION TOPICS

The watershed map shows the Sandy (80001), Clackamas (90011), Molalla (90009), and North and South Santiam (90005, 90006) watersheds southeast of Portland.

1. The area where you attended Outdoor School is on this map. Can you find the general area and the stream or its tributary in which you studied water?

   Note:

Adams	Milk Creek
Colton	Canyon Creek
Howard	Bull Run River - Laughing Water Creek
Arrah Wanna	Salmon River
Collins	Sandy River

2. The five Outdoor School sites are in how many watersheds?

   Note: Two

3. Find Mt. Hood, Mt. Wilson, Olallie Butte, Mt. Jefferson, and Three Fingered Jack on the map. Why does a major boundary line connect these peaks?

   Note: This is the crest of the Cascade Range. West of this boundary all the rivers on this map (except those of the Sandy system) flow to the Willamette River.

4. One watershed is surrounded by a dark boundary. Which one is it and why is it different than the others?

   Note: The Sandy flows directly into the Columbia (80001).

5. What watershed separates Colton and Adams from Collins, Howard, and Arrah Wanna?

   Note: The Clackamas watershed (90011).

6. In the middle of the Sandy River watershed is the Bull Run watershed.. ....an example of one watershed existing in a larger one. Draw a line around the Bull Run watershed.

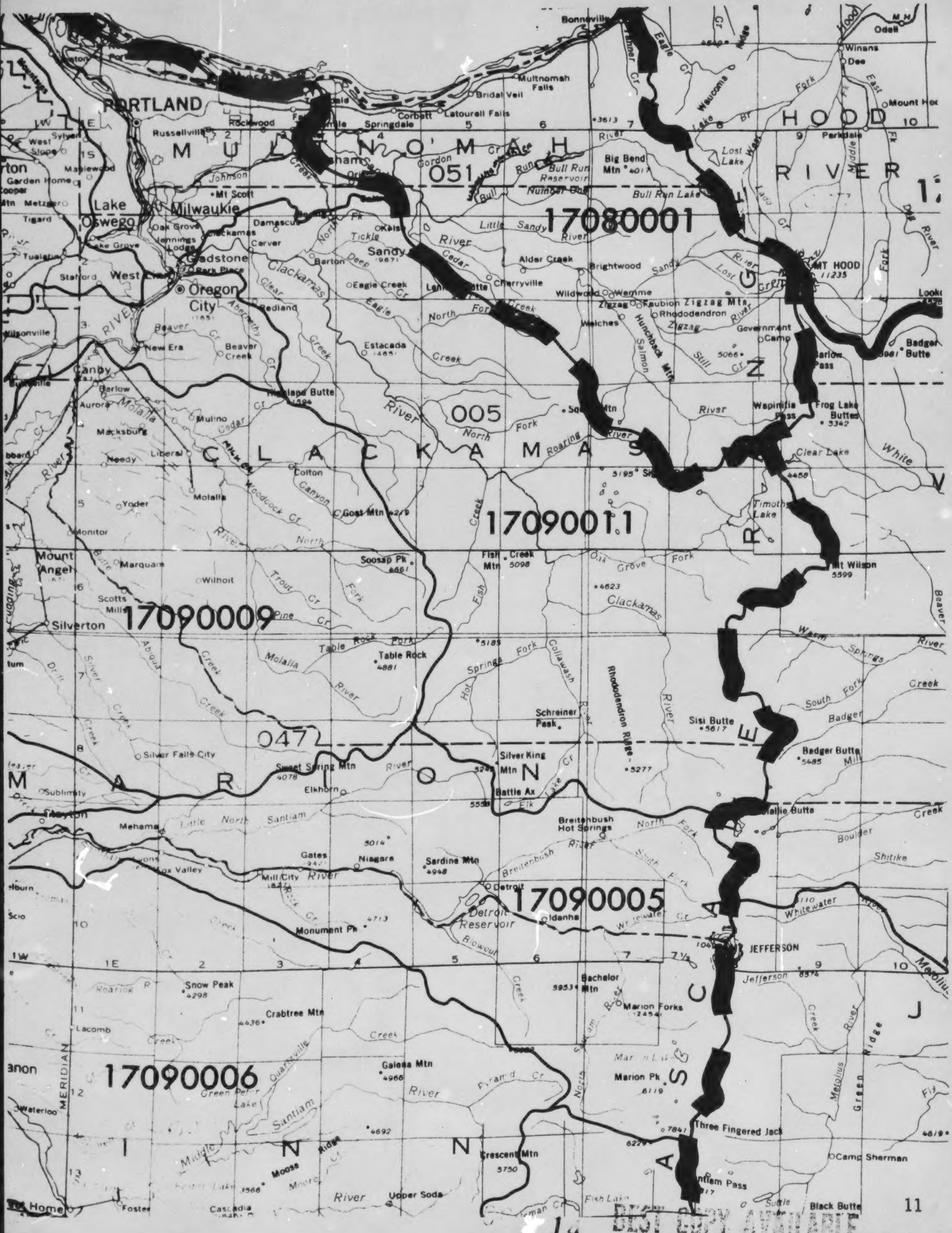
   Note: Each of the squares on the map represent 36 square miles. The area of the Bull Run watershed is 102 square miles.

7. The watersheds on this page are all part of one large watershed. Which one is it?

   Note: The Columbia.

8. The major boundary which is the eastern side of the Willamette River watershed begins in Troutdale and proceeds roughly along the Mt. Hood Highway through Sandy. Why do you think it does? Where do you think is the west side of the Willamette watershed?

   Note: The Coast Range.


17080001
17090011
17090009
17090005
17090006
051
005
047
PORTLAND
MULTNOMAH
CLACKAMAS
MARION
LINN
HOOD RIVER
CASCADE
Oregon City
Lake Oswego
Milwaukie
Gladstone
West Linn
Sandy
Estacada
Canby
Molalla
Mount Angel
Silverton
Stayton
Mill City
Detroit
Detroit Reservoir
Bonneville
Multnomah Falls
Bridal Veil
Bull Run Reservoir
Bull Run Lake
MT HOOD 11235
Government Camp
Zigzag
Rhododendron
Welches
Timothy Lake
Clear Lake
Mt Wilson 5599
Wapinitia Pass
Barlow Pass
Frog Lake Buttes 5342
Table Rock 4881
Breitenbush Hot Springs
JEFFERSON
Three Fingered Jack
Santiam Pass
Marion Forks
Camp Sherman
Black Butte
Clackamas River
Molalla River
Little North Santiam
Santiam River
Metolius
MERIDIAN

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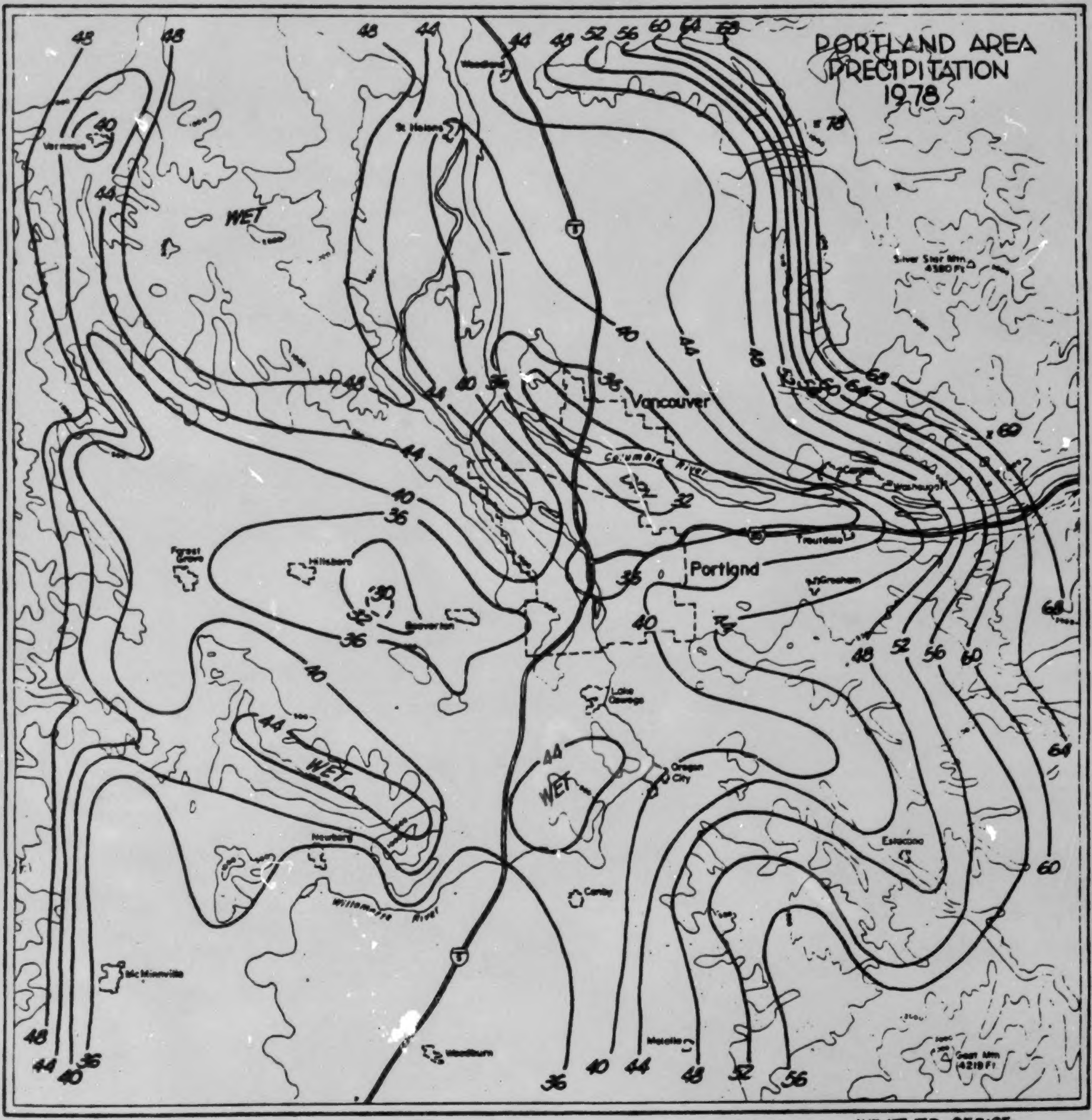
PORTLAND AREA
PRECIPITATION
1978
Vernonia
WET
St Helens
Woodland
Silver Star Mtn 4390 Ft
Vancouver
Columbia River
Camas
Washougal
Troutdale
Portland
Gresham
Forest Grove
Hillsboro
Beaverton
Lake Oswego
Oregon City
Newberg
Willamette River
Canby
Estacada
McMinnville
Woodburn
Molalla
Goat Mtn 4219 Ft
48
44
40
36
32
30
52
56
60
64
68
78

WEATHER OFFICE
BONNEVILLE POWER ADMINISTRATION

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9A. The Clackamas (90011) and Sandy Rivers (80001) are popular recreation streams for swimming, boating, and fishing. However, these streams are considered extremely dangerous because of the icy water. From the watershed map can you see why?

Note: The source of the streams is a large amount of snow melt glacier melt from the crest of the Cascade Mountains.

9B. Would you expect the Molalla (90009) watershed to be somewhat warmer?

Note: The streams are not only warmer but also have a less amount of precipitation per land area due to the lower mountains.

10. It has been said that salmon don't live in streams.....they live in watersheds. We sometimes do not remember that 99% of what affects streams begins outside of its banks....in the watershed.

In the Clackamas (90011) watershed, how could changes in the environment around Rhododendron Ridge affect salmon near the Gladstone area?

11. Locate Highland Butte, Goat Mountain, Soosap Peak, Table Rock, and Sweet Spring Mountain. Why are these peaks important? If there was a forest fire in the area how would it affect the watershed? How would it affect you here in Portland?

12. The heavy boundary line along the Cascades is also the area that receives the most rain and snowfall. Why is this?

Note: Dew point is reached sooner when incoming moist marine air is cooled by moving upward into higher elevations where temperature is lower.

What is watershed management?

Note: Managing all the natural resources of a drainage basin to protect, maintain, or improve water yield.

13. Does all the precipitation that falls in a watershed eventually flow down the streams?

Note: Over one-half the amount of precipitation evaporates or transpires before it ends up in our streams.

14. On this map can you see that you live in a watershed? What are some examples of your activity that affects the watershed and what kinds of activity "upstream" in your watershed affects you?

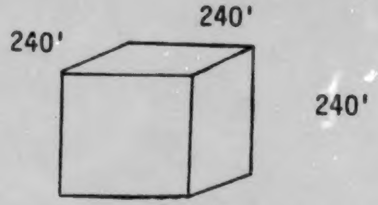
15. There are many smaller watersheds on your school grounds and in your community that are not on this map. Can you describe these? What are their boundaries? How are they connected to the large watersheds on the map?

16. If there is an average of 103,000,000 million gallons of water flowing into the city, how many cubic feet does that represent?

Note: 7.48 gallons/cubic foot

$7.48\overline{)103,000,000}$ = 13,770,053 cubic feet

This can be visualized by imagining that Portland uses daily enough water to fill a cube 240 feet on each side.



17. How much time would it take for this water to flow by you at the Outdoor School stream?

Note:
$$\frac{\text{13,770,053 cubic feet}}{\text{cubic feet per second}}$$

If the Outdoor School stream flows at 50 cubic feet per second, it would take 76½ hours to deliver Portland's daily water! An impossible task!

18. The longer that water is delayed in the land portion of the water cycle, the more uses it can serve. Explain why this is true. What are some ways that water can be delayed? How is it accelerated? What examples around the school speed up their "loss of water"? What are examples that show water is being used up faster than it is replenished?

Note: Refer to following page.

HOW MANY GALLONS OF WATER ARE FALLING?

How much water is falling on your school building? How much is falling on your school yard?

To determine gallons of water precipitated on a certain area?

$$\frac{\text{Area (square feet)} \times 144 \times \text{amount of rainfall (inches or fractions)}}{231}$$

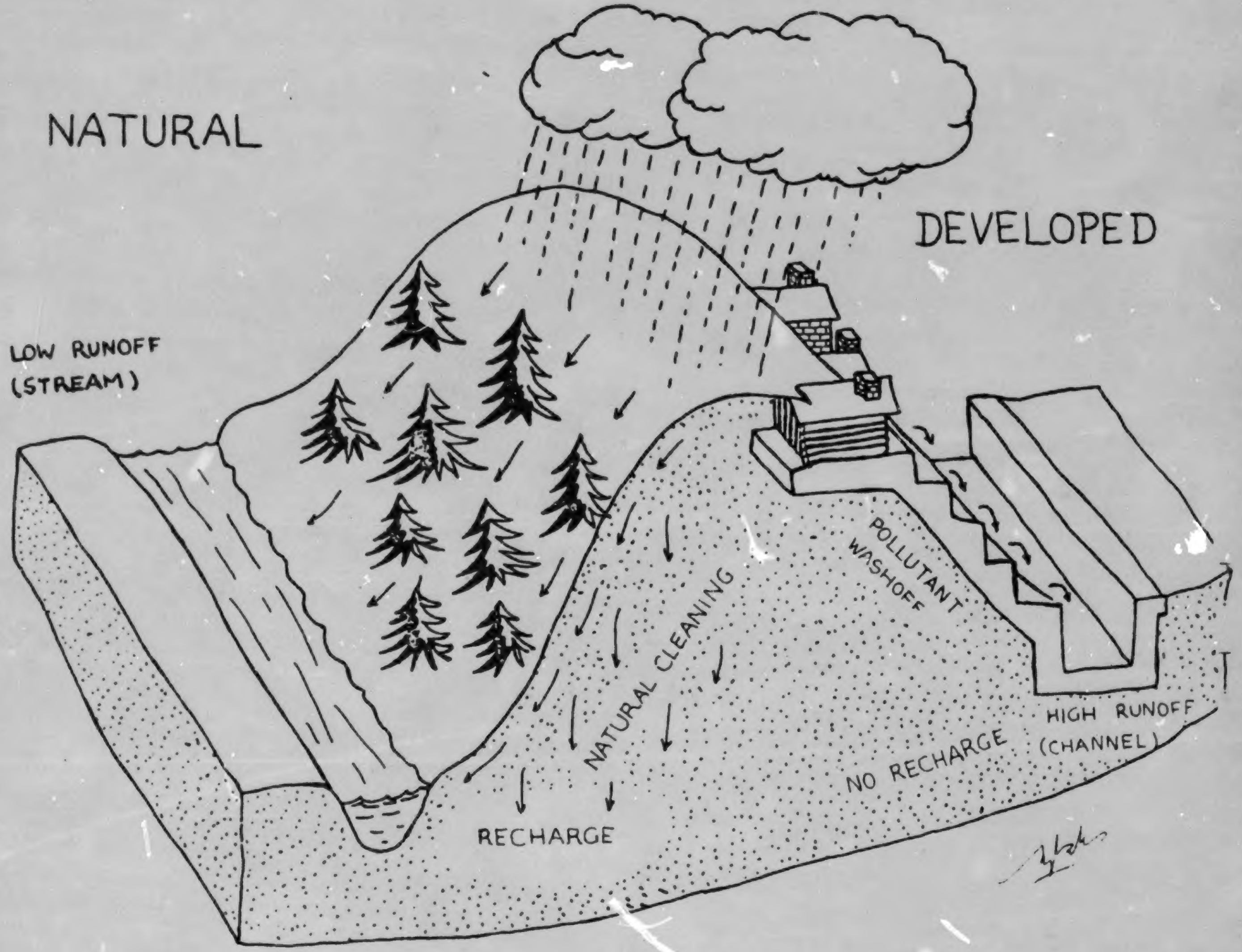
On a Portland area schoolyard about 42" of rain falls each year. 42" = 3.5 feet. If a cubic foot of water = 7.5 gallons, then (3.5 x 7.5) 26.25 gallons falls on each square foot of your schoolyard. How many square feet in your schoolyard? How much water? SEE RAINFALL MAP.

For example: Over 27,000 gallons of water will fall on one acre (43,560 square feet) if it rains one inch.

If one inch of water falls on an area of one township (six miles on a side) or one "square" on the watershed map = 626,000,000 gallons.

An average of 5,000 billion gallons of water falls on the United States every day!

WATERSHED


NATURAL
DEVELOPED
LOW RUNOFF (STREAM)
NATURAL CLEANING
POLLUTANT WASHOFF
RECHARGE
NO RECHARGE
HIGH RUNOFF (CHANNEL)

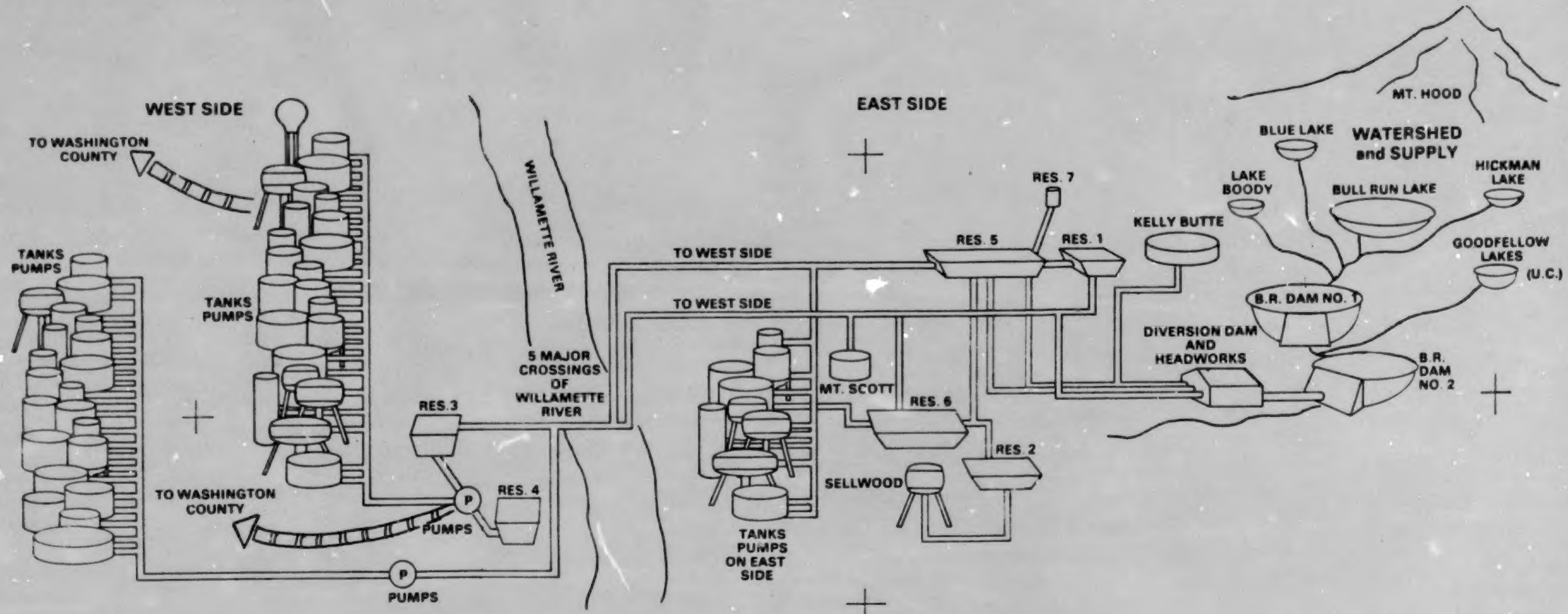
How is the speed of runoff different in the natural and developed watersheds?

Which stream would receive the most water? What problem would that cause?

Which stream would dry up first?

What examples around your school are similar to this drawing?

LINKING WATER TO OUR URBAN ENVIRONMENT



WEST SIDE
TO WASHINGTON COUNTY
TANKS PUMPS
TANKS PUMPS
TO WASHINGTON COUNTY
RES. 3
RES. 4
P
PUMPS
P
PUMPS
WILLAMETTE RIVER
5 MAJOR CROSSINGS OF WILLAMETTE RIVER
EAST SIDE
TO WEST SIDE
TO WEST SIDE
MT. SCOTT
TANKS PUMPS ON EAST SIDE
RES. 6
RES. 2
SELLWOOD
RES. 7
RES. 5
RES. 1
KELLY BUTTE
DIVERSION DAM AND HEADWORKS
B.R. DAM NO. 1
B.R. DAM NO. 2
MT. HOOD
WATERSHED and SUPPLY
BLUE LAKE
LAKE BOODY
BULL RUN LAKE
HICKMAN LAKE
GOODFELLOW LAKES
(U.C.)

WATER DISTRIBUTION BACKGROUND INFORMATION

Portland has been receiving water from the Bull Run Watershed since 1895.

Bull Run Watershed is 102 square miles of area or 65,280 acres and holds 21 billion gallons of stored water.

4 billion at Bull Run Lake
10 billion at Lake Ben Morrow (Dam #1)
7 billion at Dam #2

Through three large conduits, approximately 25 miles long, an average of 103,000,000 gallons is delivered to Portland each day. This supply varies from 70,000,000 gallons to a maximum of 225,000,000 gallons per day.

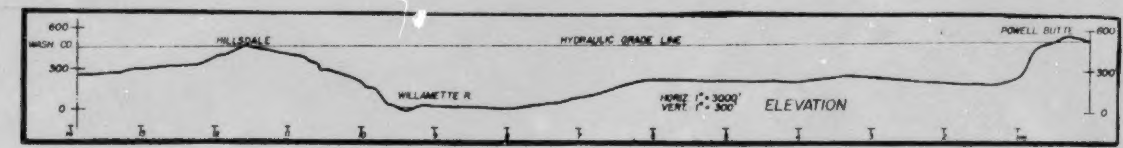
This water is stored in six large reservoirs; four at Mt. Tabor; two in Washington Park, plus fifty-eight smaller tanks and reservoirs.

The water then travels through 1,500 miles of distribution lines to over 100,000 buildings.

Over sixty-nine pumps are used to push water to the higher elevations...... (15% of all Portland water).

Seven "mains" cross the Willamette River.....bringing water to West Portland and into the Beaverton area. One conduit on the Ross Island Bridge is the only one visible to the public.

A new well field near 110th and Marine Drive (east of Portland's airport) will soon act as a backup supply to the Bull Run. This system will soon be pushing over 50,000,000 gallons per day to Powell Butte. Once in the reservoir, it can flow by gravity all the way to the Beaverton area.



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Concerns of the water manager:

1. Regulate streamflow.....enough water at the right time.
2. Improve water quality.
3. Improve the way in which water is used.
4. Be concerned about ground water.....supply and quality.
5. Find ways to add to supplies (i.e. desalting, weather modifying).
6. Improve methods of distributing water.

DISCUSSION TOPICS - "PIPES"

Many of our life support systems are concealed underneath our city streets. During construction and repairs we sometimes have the opportunity to observe and be reminded of our dependency on these "pipes".

1. What may be carried in these pipes and ducts?

   Steam..................(In downtown Portland)
   Incoming Water.........Large mains going to and from reservoirs, tanks, pumps, etc.
   Incoming Water.........To individual homes, businesses, etc.
   Outgoing Water.........Sanitary sewers from homes and businesses to sewage treatment facilities.
   Outgoing Water.........Storm sewers from streets, parking lots, rooftops, etc.
   Electricity............(Depending on area)
   Telephone..............(Certain areas)

2. How many of these pipes are tied to our natural resources?

   Note: All of them.

3. How many miles of (drinking) main line water pipe to storage tanks are there in the city?

   Note: Over 1,500 miles.

4. How many miles of sewer are under the city?

   Note: 1,400 miles.

   Fifty-six miles of storm sewer interceptor lines that take water which was destined directly for the Willamette River to the treatment plants.

5. Why is water treated?

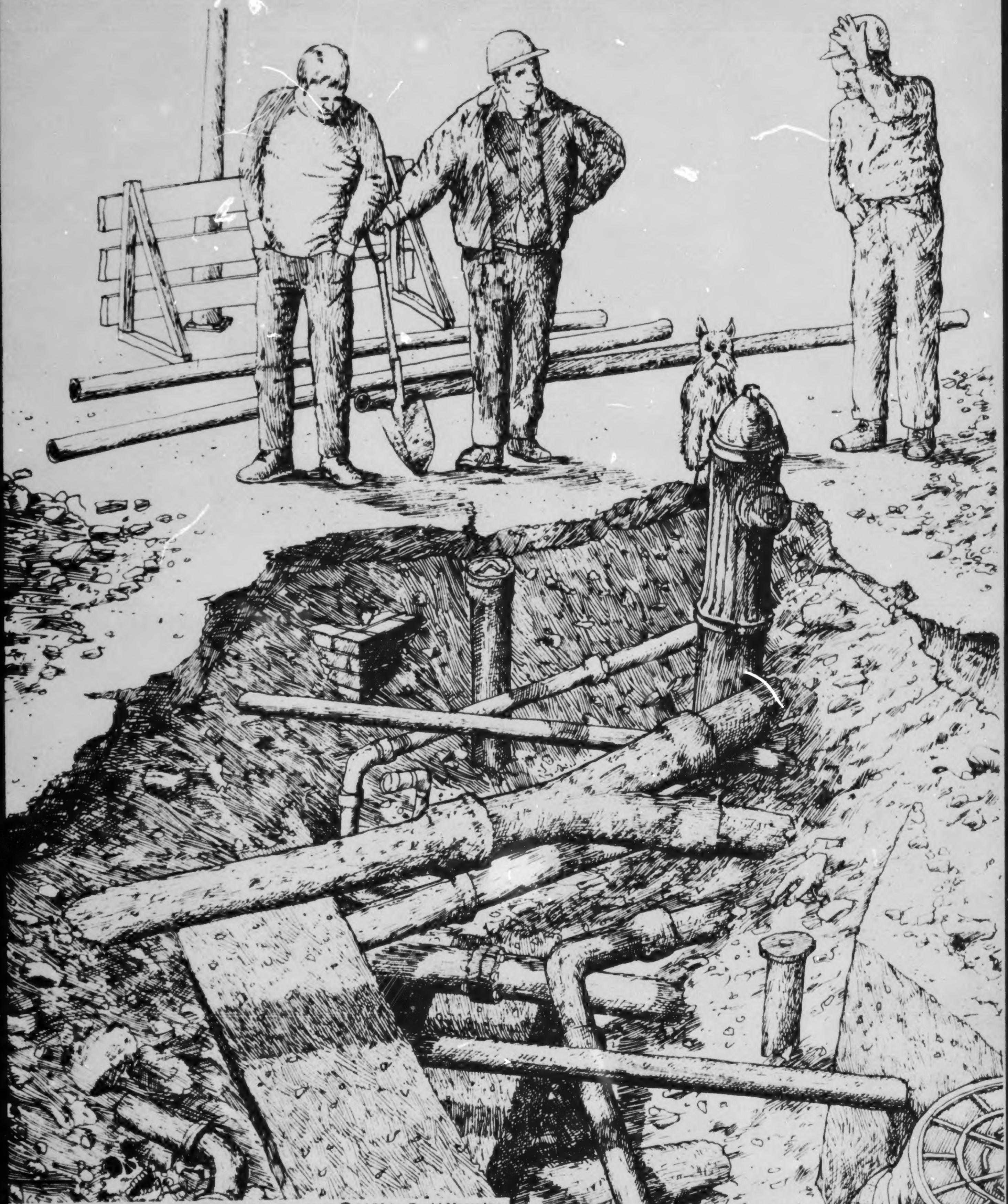
   Note: Untreated water was dumped into the Willamette until 1952. Review effect on people, aquatic animals, plants, etc.

6. What is a storm sewer?

   Note: Rainwater and snow that falls on streets, parking lots, and rooftops must either evaporate or be carried away by storm sewers.....the drains are commonly seen along our streets. Since this is a situation that obviously does not exist in the natural world, what comparisons can be made?

7. If an average 103,000,000 gallons daily flow into the city (maximum 225,000,000 gallons), why do approximately 300,000,000 gallons flow out of the city?

   Note: Precipitation that falls in the city.



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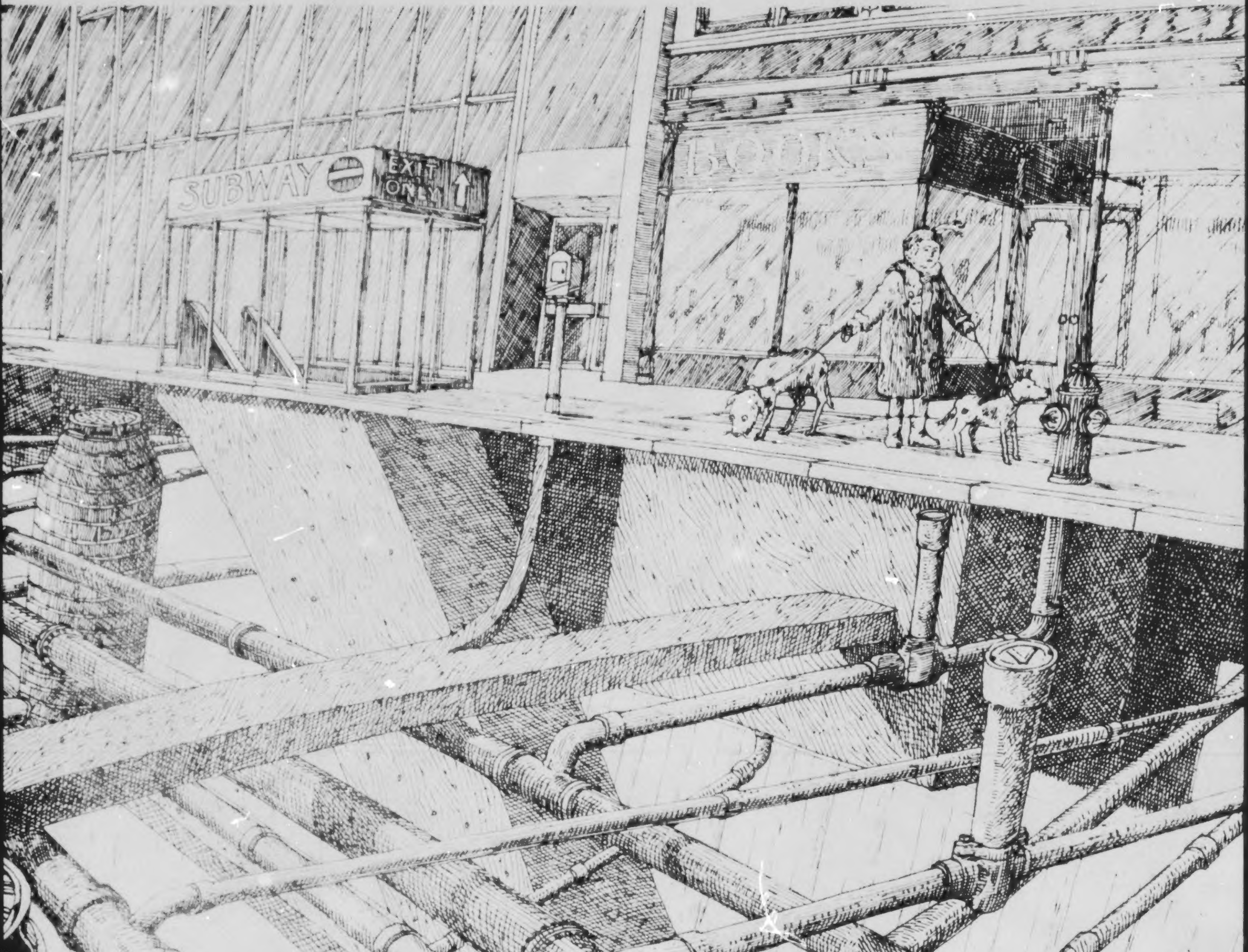
SUBWAY
EXIT ONLY
BOOKS

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8. How much waste water is flowing through these pipes?

Note: 65,000,000 to 85,000,000 gallons daily on an average.

150,000,000 gallons daily can be treated efficiently at the Columbia Boulevard treatment plant.

300,000,000 gallons is the maximum capacity.

9. Where does Portland's sewage go?

Note: Partly to the Tryon Creek treatment plant (Lake Oswego area) .....5,000,000 to 8,000,000 gallons daily.

Mostly to the Columbia Boulevard treatment plant (150,000,000 gallons daily).

10. Does the rain water going down the storm sewers get treated?

Note: Storm sewer water gets treated because it carries many pollutants. However, large storms, which put over 150,000,000 gallons per day into the system, can only be partially treated, the rest flowing directly into the Willamette and Columbia Rivers.

11. If only partially treated storm water enters the Columbia River, does this affect the river?

Note: The amount of water flowing down the Columbia is second only to the Amazon! The Portland storm water is quickly dilluted.

12. How much does it cost to dispose of our sewage?

Note: For the average family:

$4.30 per month
(90¢ for storm sewer maintenance and treatment; $3.40 for sanitary sewer treatment)

This is approximately $ .1133 per day to treat a family's waste water.

Average daily amount of waste water put into the Portland system.....75 gallons per person.

13. What would you do if the water support systems stopped working? What would be some of the reasons for failure?

Note: It is important to keep in mind that, 1) this "man made" system is dependent daily on our natural water system (Bull Run watershed); 2) our use has to be equal to or less than the supply. What would happen if our needs exceeded the supply?

14. Compare our lives in the city with present day country living and with the lives of pioneer families. Who is (or was) more dependent? Why?

Note: Consider transportation and food.

WATER SUPPLY ON TWO PORTLAND BLOCKS

GOAL

To show that all Portland residents share one resource.

1. What is this map? Why does the city need this map?
2. What is the Denver Avenue tank?

   Note: It is one of fifty-eight supply tanks in the Portland area.
3. Where does the water come from?

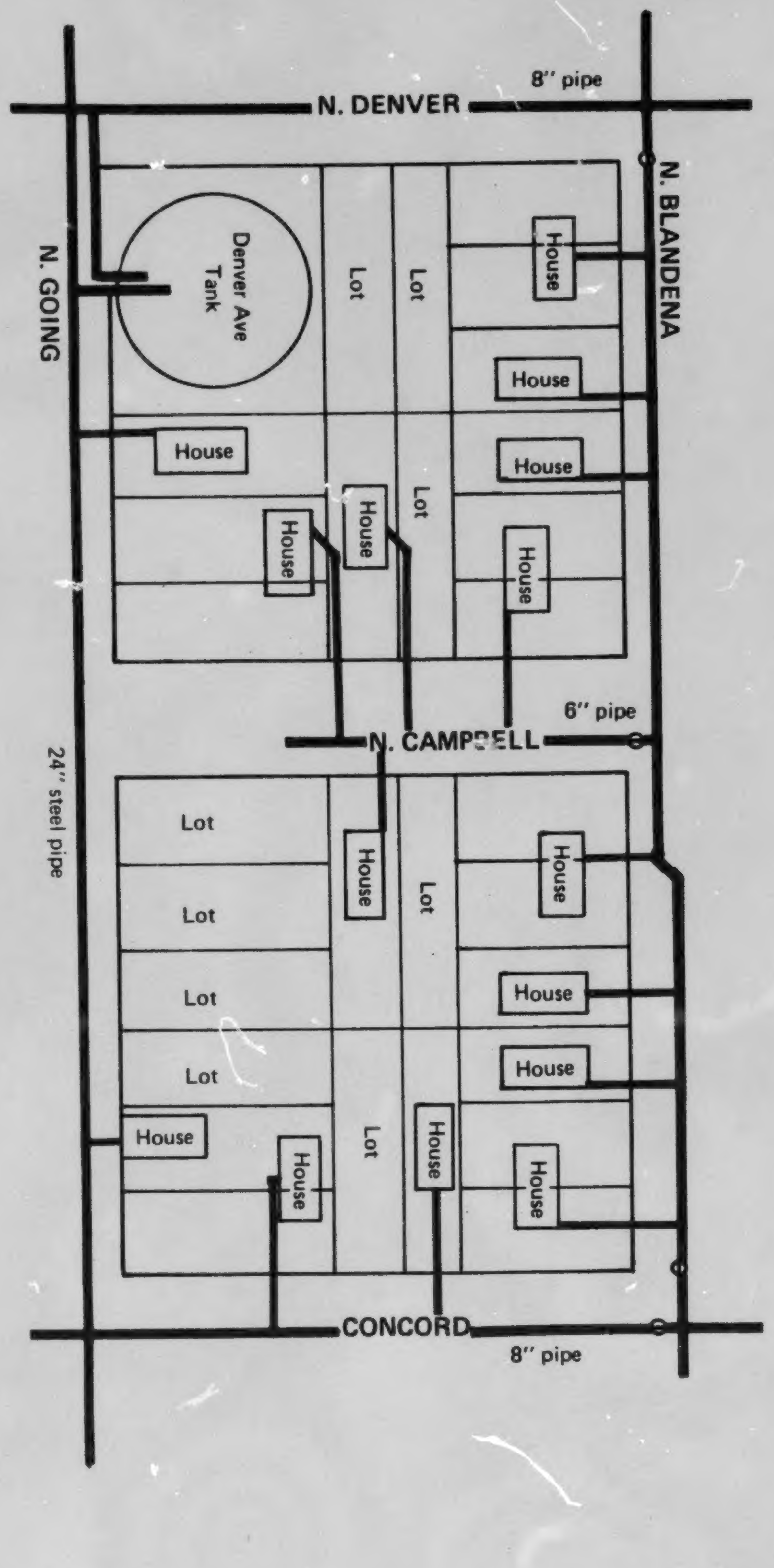
   Note: From one of the main reservoirs in Mt. Tabor.
4. Why is water stored?

   Note: To answer the fluctuating needs of the consumer.
5. What clues have you found that show water lines exist below the streets?

   Note: Valves under covers are common on any street and in most yards.
6. How does your neighbor's use of water affect your supply?
7. Why are laws needed during certain times of the year to help conserve water?

20

TYPICAL 2 BLOCK SECTION OF PORTLAND'S MASTER WATER MAP


8" pipe
N. DENVER
N. BLANDENA
N. GOING
Denver Ave Tank
Lot
Lot
House
House
House
House
House
House
Lot
House
6" pipe
N. CAMPBELL
24" steel pipe
Lot
Lot
Lot
Lot
House
Lot
House
House
House
House
Lot
House
House
House
CONCORD
8" pipe

CONCEPT

Water is a habitat for both plants and animals and water determines plant and animal distribution.

AT OUTDOOR SCHOOL

Students are introduced to a variety of aquatic plants and animals. A survey of any of the Outdoor School streams shows a variety of habitats caused by falls, riffles, pools, eddies, spawning gravel, shading bank vegetation, etc. Your students find that these areas are interrelated and together support the various animal populations.

Investigating these areas with special tools such as microscopes, and dip nets, students see examples of vital food web links....from microscopic plankton to large fish. Study of aquatic insects is important since they serve as indicators of the health of the stream environment. These insects, as well as the other organisms, all have certain requirements such as food, correct temperature, dissolved oxygen, appropriate pH, and areas for reproduction and shelter. Your students should use an ecological approach to these investigations, looking not just for the animals, but for all the factors involved in their environment.

Steelhead and salmon are examples of anadromous fish that are found in most of the Outdoor School streams. Hopefully, students will see young fry or smolts and may also see adults in spawning areas. The value of these fish and the importance of preserving the small spawning streams cannot be overstated. Understanding how specialized these fish are and how all the environmental factors of the stream contribute to their existence is an important goal of this lesson.

AFTER OUTDOOR SCHOOL

Considering the number of waterways (with their abundance of aquatic life) in the Portland area and the significance of sport and commercial fisheries to the economy of the region, it seems important to continue the study of aquatic animals beyond what is covered during the Outdoor School session. This can readily be done through the use of aquariums, field trips and films.

Many ecological principles can be demonstrated in the reduced environment of an aquarium. Life cycles of various animals such as insects, fish, and amphibians can be observed over a period of time. The effects on plants and animals by pollution, eutrophication, temperature and pH variations can also be studied. These factors can also be seen on a larger scale on field trips in the area.

CONCEPT

Water is a supplier of oxygen to aquatic plants and animals.

AT OUTDOOR SCHOOL

Testing for dissolved oxygen is probably the best single indicator of water quality. Through use of a Hach Test Kit students at Outdoor School are able to measure dissolved oxygen and relate this to the presence of animal life in the stream. They also observe how environmental factors such as temperature, stream depth and width, rocks, aquatic plants, bank vegetation, streamflow, wind, waterfalls, etc. affect the amount of dissolved oxygen. In addition to these obvious factors, a low amount of dissolved oxygen may indicate a high presence of bacteria which is using up the oxygen supply. The streams running through the Outdoor School sites are considered quite "healthy" having a dissolved oxygen count of 5-6 parts per million or greater. This is enough oxygen to supply the most demanding of Oregon fish and aquatic insects. The relative acidity or alkalinity of the water is also measured using the Hach Test Kit. These pH tests, which may indicate pollution, are another indicator of the stream's ability to support certain types of life. Our tests generally show a neutral pH (6.5 - 7.5) which indicates the most hospitable environment for living organisms.

AFTER OUTDOOR SCHOOL

Away from Outdoor School and without test kits students should still be able to look at a stream or pond (even in a picture or a film) and be able to make some judgements about its suitability as a habitat for certain fish, such as carp, bass, or salmon. Conversely, from knowledge gained at Outdoor School, students should be able to describe the most suitable habitat for each of these three species of fish. They should be able to suggest methods of improving a stream with a low amount of dissolved oxygen. Through classroom aquarium experiments students can discover how temperature affects the amount of dissolved oxygen; how plants affect the dissolved oxygen; and the effects of eutrophication in a body of water. Dams and other artificial changes in habitat also affect the quantity of dissolved oxygen in the water and could be topics for further investigation. One outcome of this lesson therefore, should be to help your students better understand the basic differences between a polluted stream and a quality stream environment.

LINKING THE OUTDOOR SCHOOL WITH THE HOME ENVIRONMENT

GOALS

Aquatic plants and animals.

Students should be learning:

- The importance of salmon and steelhead as an environmental indicator.
- How the quality of the stream and watershed affect anadromous fish.
- The significance of the term "game fish".
- The effect of man on the stream environment.

KEY WORDS

Anadromous
Aquatic
Fish Run
Steelhead
Stream Enhancement
Redd
Spawn
Alevin
Smolt
Fry
Dissolved Oxygen
pH
Game Fish

MULTNOMAH COUNTY E.S.D. FILMS

Animals That Live In Water - #40998
Aquarium Classroom Science - #81293
Conserving Our Environment, Use And Reuse - #81973
Life Cycle Of The Salmon - #80680
Living River - #82369
Salmon Story - #40793
Trout Hatchery - #81937

DISCUSSION TOPICS AND QUESTIONS

1. Why learn about salmon and steelhead?

   Note: These fish are part of the economic and cultural backbone of the Northwest. They have exacting environmental requirements and depend on the highest water quality. The sum total or culmination of the natural system is reflected in the condition of these fish populations.

2. What is an anadromous fish?

   Note: One that spends part of its life in salt water and part in fresh water. Besides salmon and steelhead, shad, smelt, lamprey, and striped bass are other Oregon anadromous fish.

3. What is a fish run?

   Note: Fish moving from salt water up fresh water streams to spawn.

4. From studying the steelhead stream map, what can you tell about the Sandy River?

   Note: Summer and winter run of steelhead.

   Fish move to the Sandy from the Columbia.

   There are no dams on this part of the Columbia.

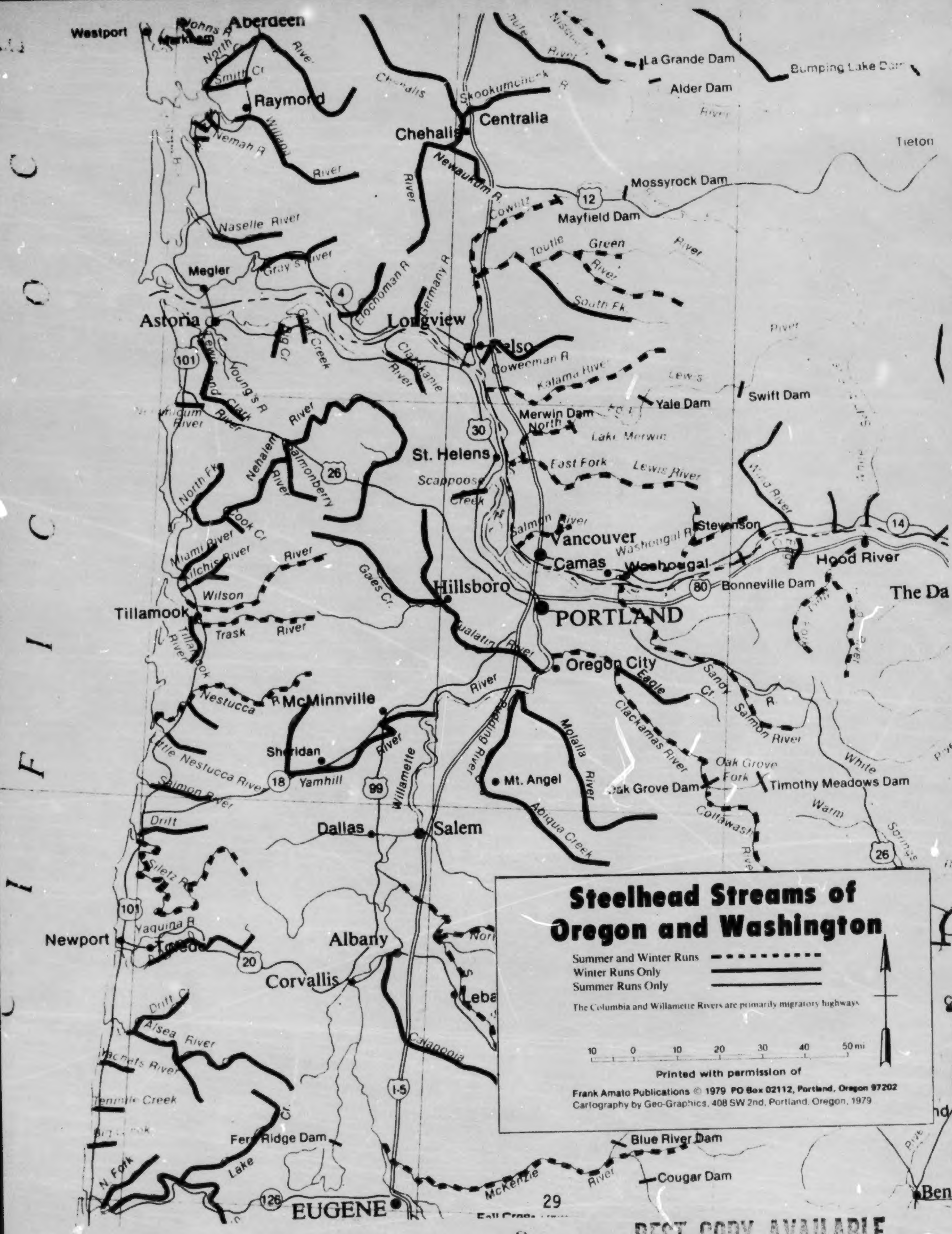
   The dotted line stops short of the head waters of the stream. Discuss why the conditions beyond that point might not be suitable for spawning.

   There are dams on the Sandy (not indicated), Clackamas, and other rivers. Discuss the need and purpose of fish ladders. Willamette falls did not have an adequate fish ladder until 1965.

5. The steelhead is a prized gamefish. Below are the 1977 catch records for steelhead on the Sandy River. Which months would you choose to fish?

Month	Number Of Fish Caught
January	537
February	636
March	841
April	335
May	174
June	96
July	93
August	12
September	62
October	62
November	96
December	2731

33


Westport
Johns R
Aberdeen
Markham
North
River
Smith Cr
Raymond
Willapa
Nemah R
River
Naselle River
Megler
Gray's River
Astoria
101
Lewis and Clark
Young's R
Big Cr
Gnat Creek
Necanicum River
Nehalem River
North Fk
Salmonberry River
26
Cook Cr
Miami River
Kilchis River
Wilson River
Tillamook
Trask River
Tillamook River
Nestucca R
Little Nestucca River
Salmon River
Drift
Siletz R
101
Newport
Yaquina R
Toledo
20
Drift Cr
Alsea River
Yachats River
Tenmile Creek
N. Fork
Lake Cr
126
EUGENE
Fern Ridge Dam
Chehalis
Skookumchuck R
Centralia
Chehalis
Newaukum R
River
Elochoman R
Germany R
4
Longview
Kelso
Clatskanie River
Coweeman R
Kalama River
Cowlitz
12
Mossyrock Dam
Mayfield Dam
Toutle
Green River
South Fk
River
Nisqually River
La Grande Dam
Alder Dam
Bumping Lake Dam
Tieton
Lewis
Yale Dam
Swift Dam
Merwin Dam
North
Lake Merwin
30
St. Helens
Scappoose Creek
East Fork
Lewis River
Salmon River
Vancouver
Camas
Washougal R
Washougal
Stevenson
Wind River
14
Hood River
80
Bonneville Dam
The Da
Gaes Cr.
Hillsboro
PORTLAND
Tualatin River
Oregon City
Eagle Cr.
Sandy R
Salmon River
Clackamas River
Oak Grove Fork
Oak Grove Dam
Timothy Meadows Dam
White River
Warm Springs
Collawash River
26
McMinnville
Sheridan
Yamhill River
18
99
Willamette
Pudding River
Mt. Angel
Molalla River
Abiqua Creek
River
Dallas
Salem
Albany
Corvallis
North
Lebanon
Calapooia
I-5
Blue River Dam
McKenzie River
Cougar Dam
Fall Creek
Bend
Cu
P
nd

Steelhead Streams of Oregon and Washington

Summer and Winter Runs - - - - - - - -
Winter Runs Only ———
Summer Runs Only ———

The Columbia and Willamette Rivers are primarily migratory highways

10 0 10 20 30 40 50 mi

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Cartography by Geo-Graphics, 408 SW 2nd, Portland, Oregon, 1979

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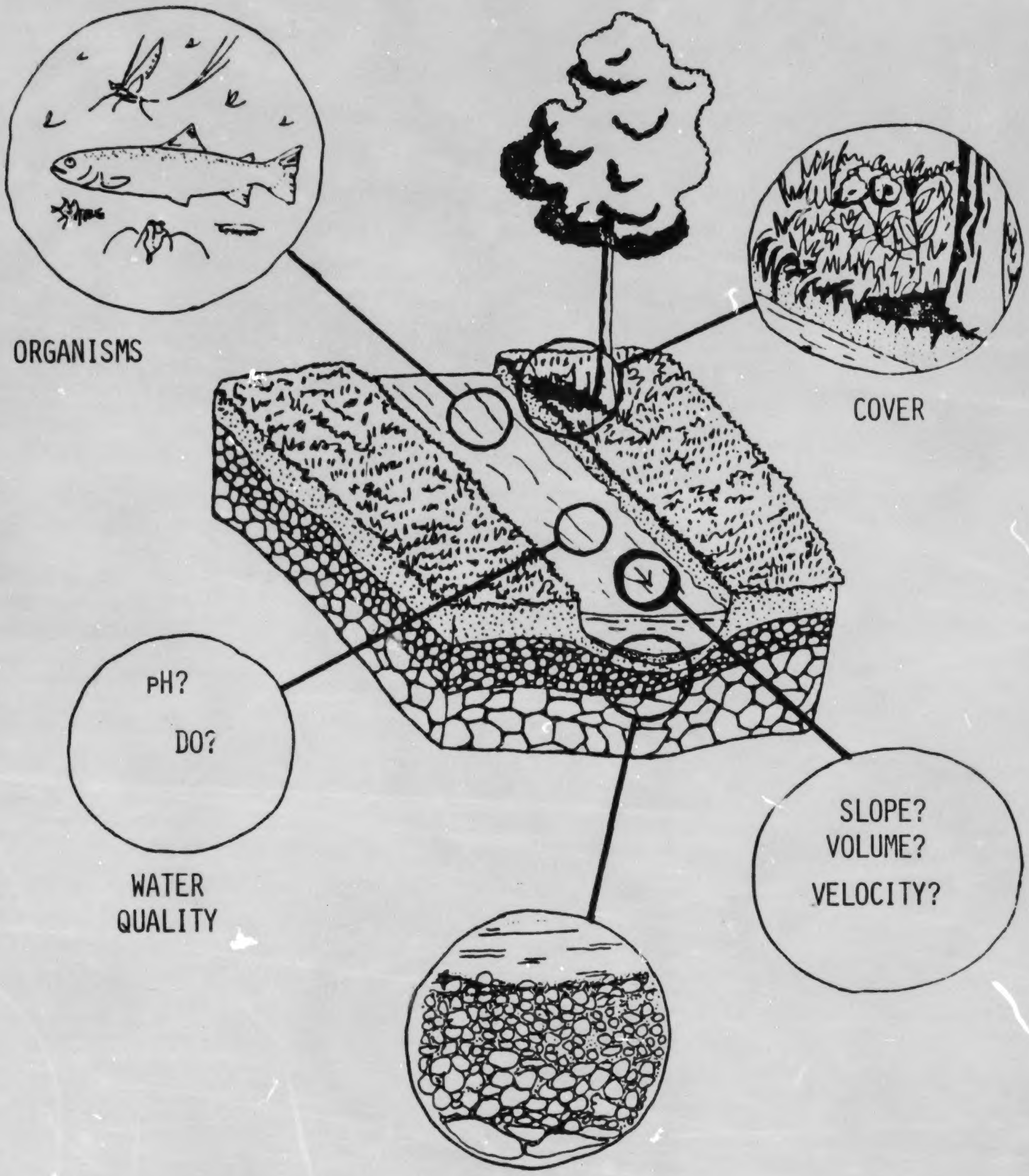
STREAM ENVIRONMENT


ORGANISMS
COVER
PH?
DO?
WATER QUALITY
SLOPE?
VOLUME?
VELOCITY?
STREAM BED (SUBSTRATE)

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6. What is the total steelhead taken during the year? Why was December the best month?

Note: 5,675 steelhead were caught.

Timing is obviously important when fishing for steelhead or any anadromous fish. Winter rains, which cause freshets, add the needed amount of water to the streams.

Compare the quality of the streams and the fishing in the Portland vicinity to that of other cities where students may have lived! Discuss reasons for the differences.

7. This was a large number of fish taken. Is this hurting the overall population of fish?

Note: Discuss the definition of "game fish" and compare it to other game.

Legal fishing, like legal hunting, is regulated to insure adequate survival stocks.

Discuss reason for seasons, bag limits, use of license money, and agencies that are responsible for the management of game fish.

8. Are some anadromous fish endangered?

Note: In the main north however, there are not only winter and summer runs of steelhead, for example, but also different "races" of fish from different areas, rivers, etc. Because the populations of some "wild stock" fish are dwindling, seasons and catch areas are limited to protect them.

9. Did you observe any salmon or steelhead in the stream at Outdoor School? What stage in their life cycle were they in?

Note:
Adults.......occasional in fall (coho and chinook salmon and steelhead)
Smolts.......4" to 5" common in fall from previous winter run (silvery)
Fry..........1" to 2" common in spring from winter eggs
Alevins......egg sack still attached (early spring)

10. The Outdoor School stream showed conditions that may have been suitable or unsuitable for salmon and steelhead. What conditions would one look for?

Note: pH, dissolved oxygen, riffles, pools (must be deep for spring chinook salmon.....a limiting factor in many streams), boulders, spawning gravel, shade and bank vegetation, turbidity, insect life, predators, volume, and velocity.

11. Find the Toutle River on the map. After the eruption of Mt. St. Helens, there was concern over what would happen to the fish in this river. What changes in the river could have happened that would have affected the fish population?

Note: Temperature increase, removal of bank vegetation, increase in erosion, siltation, flooding, covering some and scouring out other spawning areas, insect life reduced. In general, every factor was changed.

12. The Toutle River/Mt. St. Helens situation is an example of natural impact as opposed to man's impact on the environment. What are some other natural impacts? How do they differ from man caused impact?

    Note: Forest fire, floods, insect outbreaks, natural extinction of animals or plants.

13. Locate the coastal streams on the map. Why are they so short? As a habitat for anadromous fish, how are they different from the inland streams?

    Note: These streams have only a short, steep run until they reach the ocean.

    These fish populations are more stable due to less impact from man and river-based industry, however these streams have greater extremes from high to low water due to their shortened drainage area and extreme winter precipitation, compared to inland areas.

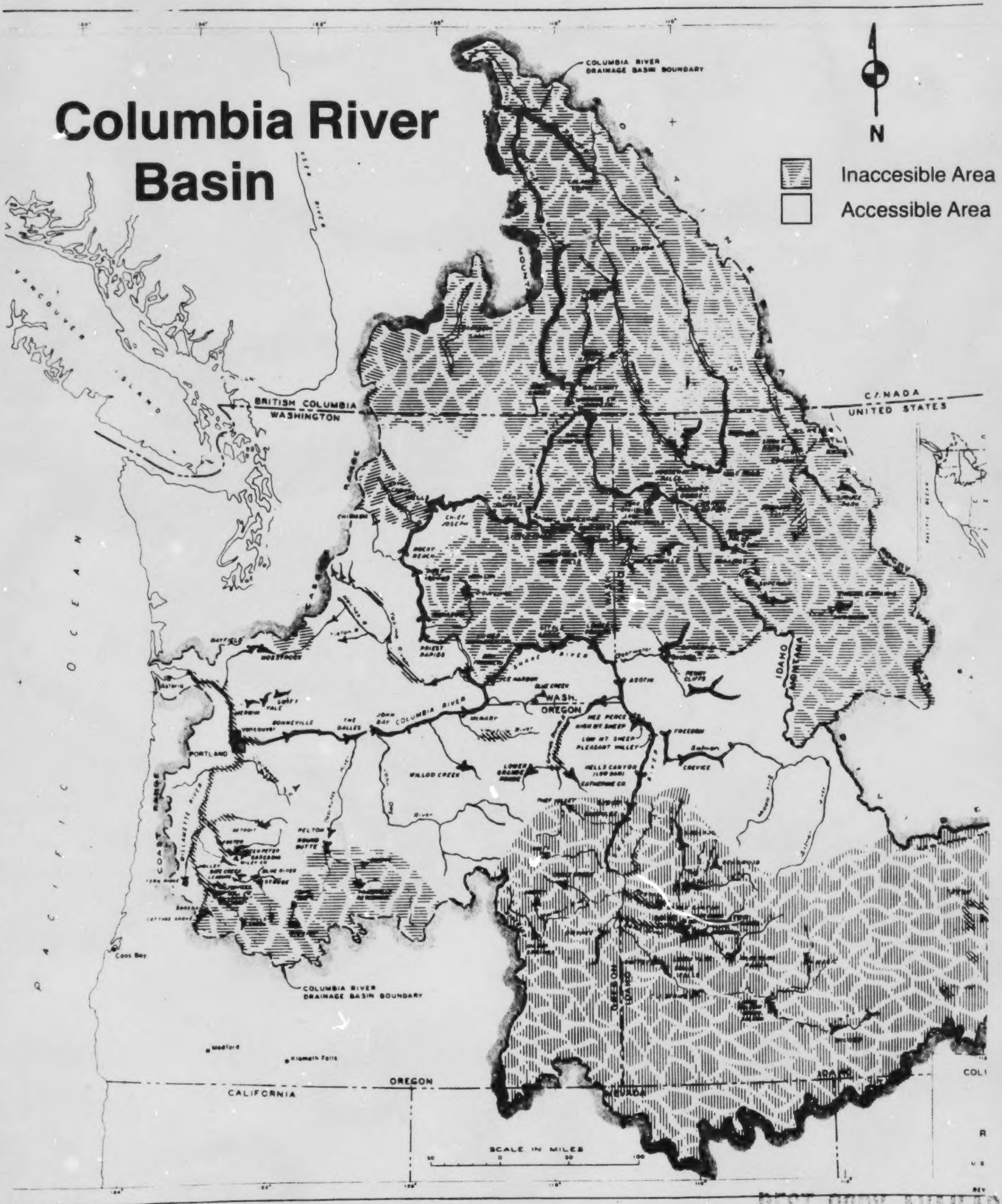
14. The Columbia River Basin Map shows that salmon and steelhead, on their journey to spawning grounds in the Columbia watershed are stopped by the Grand Coulee Dam on the Columbia, the Brownlee Dam on the main stem of the Snake River, and the Dworshak Dam on the Clearwater River near Lewiston, Idaho. They can travel the entire distance of the Salmon River. What is the reason for this? How does this affect salmon, other wildlife, and also people?

    Note: Our demand for more electricity is causing more (and higher) dams on the watershed. Many of these do not have proper fish ladders. What are the alternatives? Who pays for this? How do our values affect these rivers?

15. Fall salmon runs into the Willamette River above Portland increased from only 79 fish in 1965 to 32,245 in 1974. Why such a large increase?

    Note: Fish ladder at Willamette Falls and less water pollution.

Columbia River Basin


Inaccesible Area
Accessible Area
N
Columbia River Drainage Basin Boundary
British Columbia
Washington
Canada
United States
Vancouver Island
Pacific Ocean
Astoria
Portland
Bonneville
The Dalles
John Day
Columbia River
McNary
Chief Joseph
Rocky Reach
Priest Rapids
Snake River
Wash.
Oregon
Idaho
Montana
Nez Perce
High Mt. Sheep
Low Mt. Sheep
Pleasant Valley
Hells Canyon
Willow Creek
Pelton
Round Butte
Coos Bay
Medford
Klamath Falls
Oregon
California
Nevada
Scale in Miles
50
0
50
100

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Map of the Columbia River system showing area accessible to salmon and steelhead in 1968.

ANADROMOUS FISH SURVIVAL

1. What life stages of anadromous fish did you observe in the Outdoor School stream?
2. What life stages of salmon or steelhead might have been in the stream during your stay at Outdoor School?

Eggs ____________________

Fry ____________________

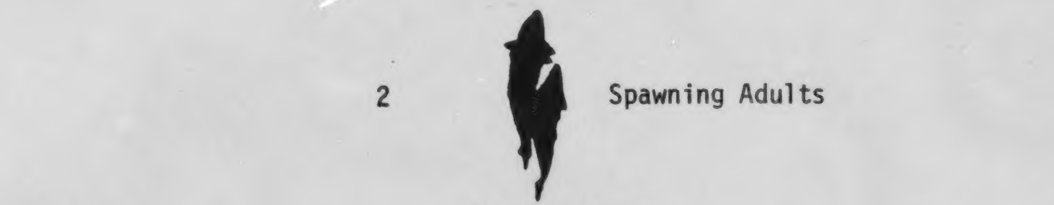
Smolts ____________________

Ocean Adults ____________________

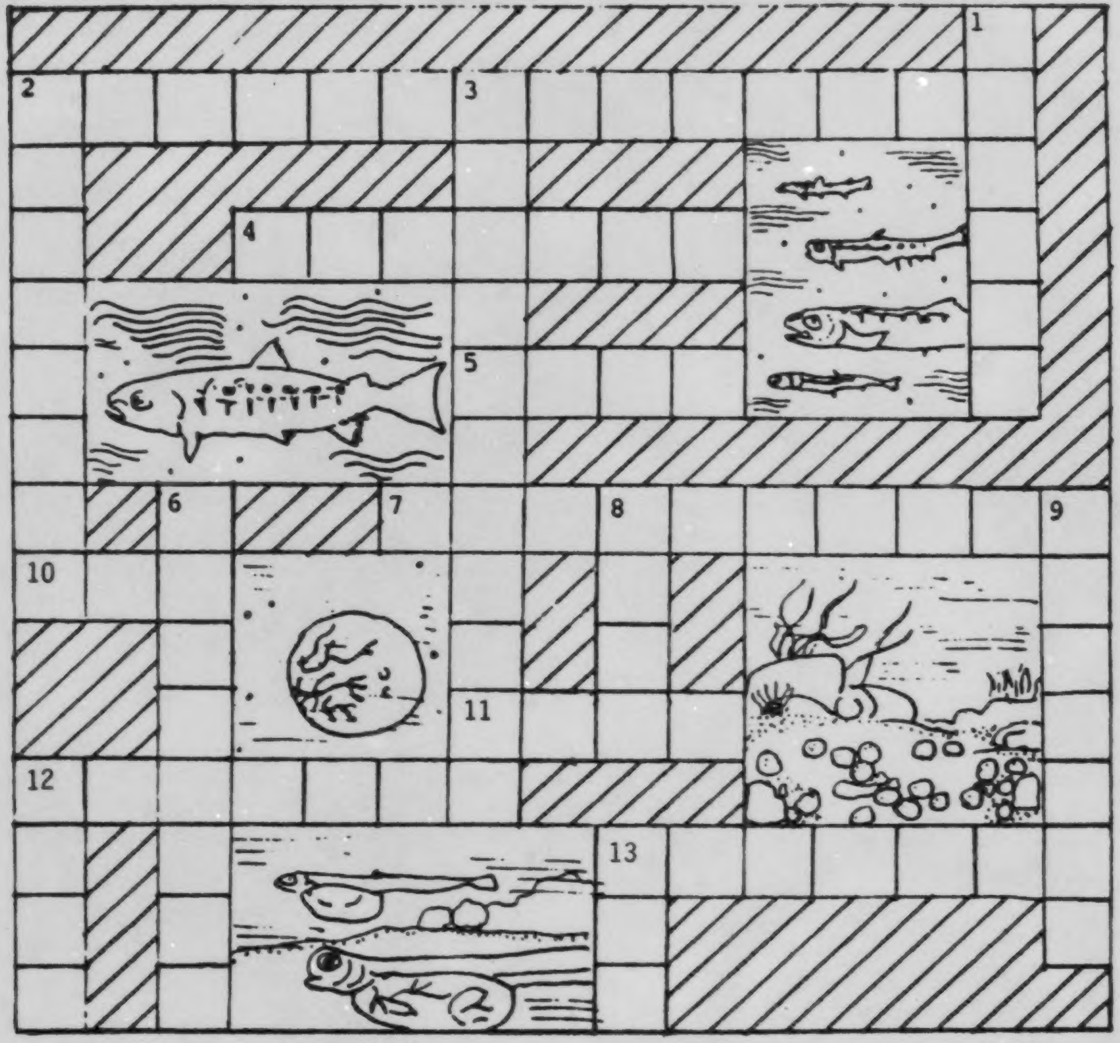
Spawning Adults ____________________

3. What are the threats that caused the decrease in numbers in the fish below?
4. What are the advantages and disadvantages to this decrease in numbers?

SURVIVAL STATISTICS


2
Spawning Adults
4
Ocean Adults
50
Smolts
300
Fry
3,000
Eggs

LIFE CYCLE VOCABULARY CROSSWORD PUZZLE



ACROSS

2. Also belonging to the salmonids.
4. Young salmon with yolk sac still attached.
5. Depression dug by spawning female salmon.
7. Meaning born in fresh water, mature in salt water and return to spawn in fresh water.
10. Should not be used to catch salmonids.
11. Salmon lay their eggs in a (No. 5) like birds do in a _______.
12. Natural environment for a species.
13. Relationship between living organisms and their environment.

DOWN

1. A habitat vital to spawning salmon.
2. Laying eggs.
3. Total surroundings.
6. Newly laid eggs must _________ over the winter.
8. Hindrance to migrating salmon.
9. _________ salmon are often canned for food.
11. An outdoor walking activity alongside a natural stream.
12. Many people like to __________ salmon.

****

WORD LIST

Steelhead Trout
Gun
Eat

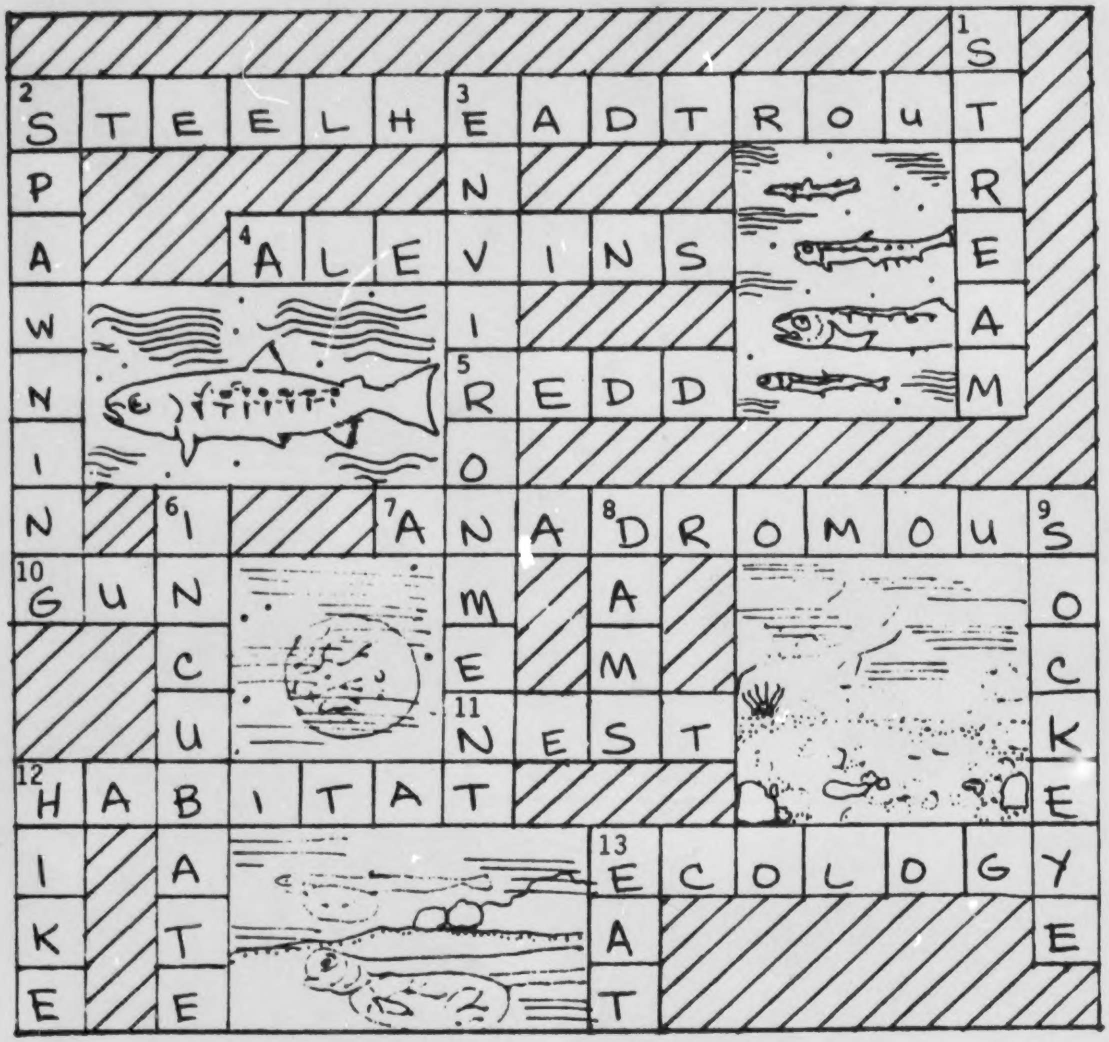
Incubate
Spawning
Habitat

Nest
Redd
Ecology

Environment
Anadromous
Dams

Alevins
Hike
Sockeye
Stream

LIFE CYCLE VOCABULARY CROSSWORD PUZZLE


1 STREAM
2 STEELHEADTROUT
2 SPAWNING
3 ENVIRONMENT
4 ALEVINS
5 REDD
6 INCUBATE
7 ANADROMOUS
8 DAMS
9 SOCKEYE
10 GUN
11 NEST
12 HABITAT
12 HIKE
13 ECOLOGY
13 EAT

ACROSS

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9. _________ salmon are often canned for food.
11. An outdoor walking activity alongside a natural stream.
12. Many people like to __________ salmon.

CONCEPT

Falling water produces usable power.

AT OUTDOOR SCHOOL

Students learn how the stream flowing through the Outdoor School site is capable of producing electricity. This is especially appropriate in the Northwest because of our dependence on rivers for most of our electricity. Demonstrations using waterwheels show students how energy can be extracted from flowing water.

Water gains speed the further it falls. This is shown by pouring water onto a waterwheel from various heights and letting students observe that the higher the point from which one pours water, the faster the wheel turns (more energy is produced). Students can project the results of constructing a dam for the purpose of increasing "head" or waterdrop so that electrical generators can convert water's energy to electrical energy. Knowing "head" and the cubic feet per second flow....one can estimate the stream's ability to produce electricity.

Students can also understand the concept of stored or potential energy from observations of reservoirs created by dams. With this knowledge, they can better understand what happens during "peaking" periods when larger volumes of water are released through generators to answer the fluctuating needs of the consumer. Your class can see that a stream's potential for generating electricity depends on rainfall, snow melt, stream volume and drop in elevation. As a result, conservation of electricity is particularly crucial at certain times during the year.

AFTER OUTDOOR SCHOOL

Your students, having seen how electricity can be derived from a stream, are on their way to understanding some of the complexities of supplying their home environments with electricity. Our increasing needs for energy can be answered both by increasing the supply and by increasing our practice of conservation. Although your students can immediately do little to help develop new power supplies, they can learn about various unused energy sources and do a great deal about conservation of this energy. Conservation, rather than supply, should be emphasized because the other alternative, increase in supply, is very costly, invites impact on our environment and brings us closer to the maximum limit of energy that can be produced.

This introduction to hydroelectric power can be followed by an investigation of alternative energy sources. Portland area students should realize that while most of their electricity presently comes from dams, some may also come from the Trojan Nuclear Plant, from the coal-fired Boardman plant, or the oil and gas generators in Clakskanie. These all create steam to drive electricity-producing generators.

One of our goals is to allow students to see that all energy sources have some degree of impact on the environment. Although this subject is extremely complex, sixth graders can begin to understand a few of the issues involved. The obstacles to salmon migration that dams create would be one easy example of the impact hydroelectric energy has on the environment.

Briefly, the areas for follow-up are: 1) further investigation of hydroelectric power; 2) importance and practices of conservation; 3) alternative sources of energy; 4) environmental impact from various energy sources.

LINKING OUTDOOR SCHOOL WITH THE HOME ENVIRONMENT

GOALS

Students should be learning:

How water is used to produce electricity.

Various alternative energy sources.

How each energy source has environmental impact.

How to calculate potential electricity from a stream.

The limits to our most commonly used energy sources.

To understand the role of conservation when using energy.

KEY WORDS

Cubic Feet Per Second.....7.48 gallons passing one point in a stream (standard measure of river flow)

Head.....vertical distance from the reservoir surface down to the water in the stream below the turbine

Kilowatts.....1,000 watts

K.W.H......1,000 watts produced or used over an hour

Megawatt.....1,000 kilowatts

Reservoir.....stored water behind a dam

Peaking Period.....typically morning and evening periods when large amounts of water must be released in response to power needs

MULTNOMAH COUNTY E.S.D. WATER POWER FILMS

Columbia River - #40188

Great River Of The West Columbia - #80566

DISCUSSION TOPICS - COLUMBIA HYDROELECTRIC POWER

1. What is the shaded boundary around the large area on the map?

   Note: This is the entire Columbia River watershed.

2. How many states and provinces does it occupy?

   Note: Part of Oregon, Washington, Idaho, Montana, Wyoming, Nevada, Utah, and British Columbia.

3. The Continental Divide is the eastern boundary of this watershed. Where do the rivers flow that are east of this boundary?

   Note: This boundary is the beginning of the Mississippi watershed and all waters flow east into the Atlantic Ocean from there.

4. How many dams can you count on the map?

   Note: There are over 120 dams, 55 of which are major hydroelectric sites.

5. Why are there so many?

   Note: Mainly for the production of electricity plus others for flood control and irrigation.

   Over one-half of the fresh water used in this country is for irrigation.

6. Is the electricity being entirely used?

   Note: Even with these dams there are occasional shortages. During high rainfall times, power is sold to other states and even spilled at the dams and lost to electrical production.

7. Where is the electricity being used?

   Note:

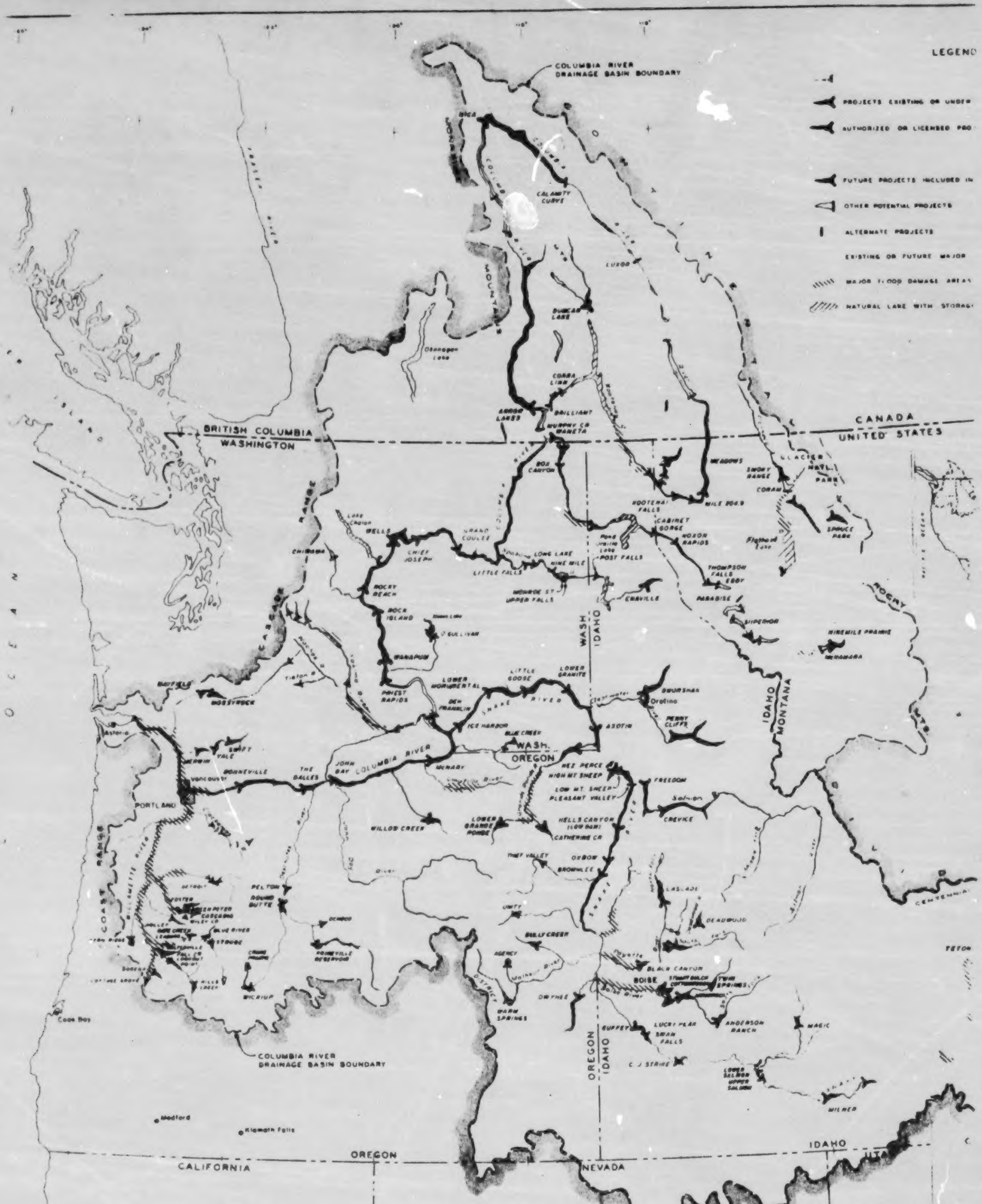
Residential	47%	Industrial	17%
Commercial	25%	Other	9%

8. What is the outlook for the future?

   Note: All the areas for major dam construction have already been used. We are reaching the Columbia River's limits. In Portland, annual load growth is 5%.

9. Discuss the advantages and disadvantages of hydroelectric power.

   Note:
   1. Economical power + flood control + irrigation + transportation.
   2. Loss of fish habitat, siltation, flooding of historical sites, rerouting of highways, loss of game habitat, loss of water quality due to heat, and suspended particles.


LEGEND
PROJECTS EXISTING OR UNDER
AUTHORIZED OR LICENSED PRO
FUTURE PROJECTS INCLUDED IN
OTHER POTENTIAL PROJECTS
ALTERNATE PROJECTS
EXISTING OR FUTURE MAJOR
MAJOR FLOOD DAMAGE AREAS
NATURAL LAKE WITH STORAG
COLUMBIA RIVER DRAINAGE BASIN BOUNDARY
MICA
CALAMITY CURVE
DUNCAN LAKE
CORRA LINN
BRILLIANT
ARROW LAKES
MURPHY CR.
WANETA
BRITISH COLUMBIA
WASHINGTON
CANADA
UNITED STATES
BOX CANYON
MEADOWS
SMOKY RANGE
CORAM
GLACIER NAT'L PARK
MILE 204.9
KOOTENAI FALLS
CABINET GORGE
NOXON RAPIDS
THOMPSON FALLS
EDDY
PARADISE
SPRUCE PARK
Flathead Lake
GRAND COULEE
CHIEF JOSEPH
WELLS
CHELAN
LONG LAKE
NINE MILE
POST FALLS
LITTLE FALLS
MONROE ST.
UPPER FALLS
ROCKY REACH
ROCK ISLAND
WANAPUM
PRIEST RAPIDS
LOWER MONUMENTAL
LITTLE GOOSE
LOWER GRANITE
ICE HARBOR
SNAKE RIVER
ASOTIN
PENNY CLIFFS
Orofino
DWORSHAK
NINEMILE PRAIRIE
IDAHO
MONTANA
WASH.
OREGON
NEZ PERCE
HIGH MT. SHEEP
LOW MT. SHEEP
PLEASANT VALLEY
FREEDOM
Salmon
CREVICE
HELLS CANYON
CATHERINE CR.
OXBOW
BROWNLEE
McNARY
JOHN DAY
COLUMBIA RIVER
THE DALLES
BONNEVILLE
Vancouver
PORTLAND
Astoria
MERWIN
SWIFT
YALE
WILLOW CREEK
LOWER GRANDE RONDE
PELTON
ROUND BUTTE
OCHOCO
PRINEVILLE RESERVOIR
BLUE RIVER
DETROIT
COUGAR
LOOKOUT PT.
HILLS CREEK
BOISE
BLACK CANYON
TWIN SPRINGS
ANDERSON RANCH
LUCKY PEAK
SWAN FALLS
C.J. STRIKE
LOWER SALMON
UPPER SALMON
MILNER
MAGIC
CASCADE
DEADWOOD
OWYHEE
WARM SPRINGS
AGENCY
BULLY CREEK
Coos Bay
Medford
Klamath Falls
COAST RANGE
CASCADE RANGE
ROCKY MOUNTAINS
PACIFIC OCEAN
CALIFORNIA
NEVADA
UTAH
CENTENNIAL
TETON
SCALE IN MILES
50
0
50
100

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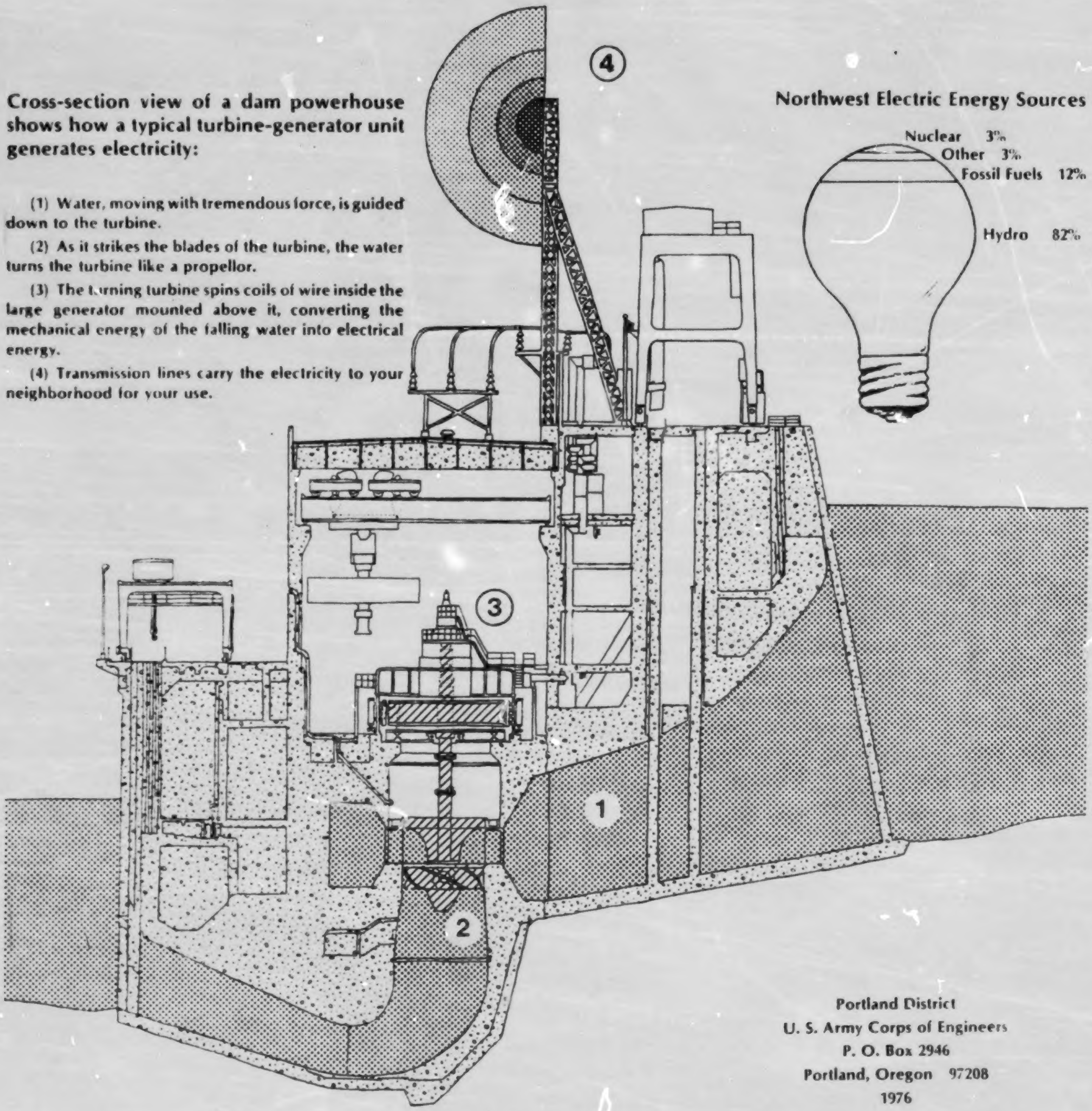
Cross-section view of a dam powerhouse shows how a typical turbine-generator unit generates electricity:

(1) Water, moving with tremendous force, is guided down to the turbine.

(2) As it strikes the blades of the turbine, the water turns the turbine like a propellor.

(3) The turning turbine spins coils of wire inside the large generator mounted above it, converting the mechanical energy of the falling water into electrical energy.

(4) Transmission lines carry the electricity to your neighborhood for your use.



Northwest Electric Energy Sources

Portland District
U. S. Army Corps of Engineers
P. O. Box 2946
Portland, Oregon 97208
1976

BEST COPY AVAILABLE

4,

FALLING WATER PRODUCES POWER

DISCUSSION TOPICS

Hydroelectric power accounts for 12% of our nation's electricity, but contribute to most (82%) of the electricity in the Portland area. Why is this? What are the advantages and disadvantages of this use? (Coal = 51%; natural gas = 15%; nuclear = 11%; oil = 10.8%; geothermal wood and waste = .2%)

How is electricity produced from streams? How does waterflow and speed (cubic feet per second) and the distance water falls (head), affect the quantity of electricity?

To Review: Estimate the amount of electricity that could be produced from the Outdoor School stream.

Needed:
1. Cubic feet per second of the stream.
2. Amount of head (water drop) that may exist or could be created by a dam.

KILOWATTS = .04 x cubic feet per second x head (in feet).

Students will see that the amount of kilowatts greatly increases with the distance of water drop. What are the impacts to the environment to this increased height? Consider fish migration, reservoirs, water use, etc.

Now it is possible to:

1. Understand generally about the source of electricity in the Portland area.
2. Understand the importance of hydroelectric power in the Northwest and the quantity of water needed to produce this electricity.
3. Understand the alternative sources and cost of electricity.

1,000 kilowatt hours = 6,000,000 gallons through Bonneville turbines *
= 254 cubic feet per second
= 1340 pounds of coal
= 1.7 barrels of oil (42 gallons/barrel)
= .04 pounds of uranium
14,000 kilowatt hours = average annual consumption per household

To run a 1,000 watt hair dryer for 1 minute = 100 gallons of water must pass through the Bonneville turbines.

---

* 300,000 gallons through all the dams from the Canadian border to the Pacific could produce the same power.

COSTS

Since electricity comes from many sources, the cost (at 4¢ per kilowatt hour) is an average from different sources.

Example:	.07¢	Dams constructed long ago
	2.15¢	Trojan plant
	4.0 ¢	Coal-fired Boardman plant.....315 tons/hour (Wyoming coal) maximum use
	6.5 ¢	Oil and natural gas plant at Clatskanie plant (Beaver)
	7.0 ¢	Bull Run hydroelectric project

Cost: 1,000 kilowatt hours = approximately $40.00 to a Portland home per month.

The average annual electric bill - 4¢/kwh x 14,000 = $560.00
= 84,000,000 gallons of water through Bonneville

Bonneville Dam - 130,000 cubic feet/second *produces 514 megawatts (514,000 kilowatts)

* 1 cubic foot per second = 449 gallons per minute
= 26,940 gallons per hour

APPLIANCE	AVERAGE WATTAGE	KWH PER USE	KWH PER MONTH	MONTHLY COST AT 4¢/KWH
Water Heater 52 Gallon/140°	4500	17	500	Every Day - $20
Range Top 6" Element	1600	.35	24	68 Uses - $ .96
8" Element	2100	. 6	11	18 Uses - $ .44
Toaster	1000	.056	2.6	48 Uses - $ .08
Radio/Phonograph	109	.125	11.25	3 Hrs./Day - $ .45
TV/Color Tube	240	.24	36	5 Hrs./Day - $1.44
Blow Dryer	1000	.25	7.5	Once/Day - $ .30
Lighting Incandescent	100	. 1	24	8 Hrs./Day - $ .96
Flourescent	40	.04	9.6	8 Hrs./Day - $ .38

CONCEPT

The sun's energy is transferred to the animal world through plants.

Plants have the role of producer and decomposers in the ecosystem.

AT OUTDOOR SCHOOL

Students at Outdoor School can understand that photosynthesis is the means by which green plants use sunlight (in the presence of chlorophyll) to change carbon dioxide and water into food....some being used by the plant and some being stored. In this way green plants are able to transfer energy from the sun to all animals. Since no animal can make its own food, the essential role of plants cannot be overstated.

This process is one of the most important concepts a student may learn at Outdoor School. Without knowledge of this basic idea, most of the other concepts about plants and animals would be only superficially understood. For instance, the fact that plants act as producers is the foundation upon which food pyramids and food chains are built. The fact that plants require light to carry on photosynthesis is also a beginning to further understanding plant competition, shade tolerance, adaptation, or in general, basic plant ecology.

Students can observe and investigate many examples of this process which is going on around them. They will observe that most plants have chlorophyll, but exceptions become obvious when they see mushrooms growing on dead logs. Lacking chlorophyll, these decomposers survive by taking food for energy from dead plant material....plants that at one time produced food using chlorophyll.

Many food producing plants may be deciduous, but may not be growing while your students are on the site. Comparing growth rings of deciduous and coniferous trees will show that conifers carry on photosynthesis throughout the year (except during freezing). Students also see how temperature and moisture are critical to the rate of this growth. By looking at a tree cross-section as well as the entire plant, the purpose of the sap and heartwood, bark, roots, leaves, stomata, and other components can be studied in relations to photosynthesis. Looking at a cross-section of the forest community, one can see various stories of plant growth. The leaves of the dogwood, typical of shade tolerant understory, are larger and are displayed more horizontally than those of the intolerant species. Students begin to see that a forest or field is not a haphazard mass of plants, but a true community, each affecting its surroundings and each adapted for efficient use of the sun's energy.

AFTER OUTDOOR SCHOOL

The school yard and surrounding neighborhood can be an on-going laboratory for reinforcing the concept of photosynthesis. Observation over several months is a key element in understanding how changing environmental factors affect germination and plant growth. Soil temperature, air temperature, effects of shade from plants and buildings, rainfall, soil conditions and other factors can be measured and recorded in relation to the growth of plants. These experiments and observations really become significant only when related to the student's own life.

Each day your students use energy. A general survey of the amount and source of this energy will show that a large percentage comes from the past photosynthesis of plants. Our daily consumption of food, part of our heat and electricity, our transportation, and our use of plastics and other manufactured products are better understood when applied to the role of plants as producers of food and storers of energy.

LINKING OUTDOOR SCHOOL WITH THE HOME ENVIRONMENT

GOALS

Students should be learning:

How plants have an essential role in the food web.

The link between the sun, plant growth, and stored energy.

That our need for stored energy from past plant photosynthesis can be supplemented with direct energy from the sun.

KEY WORDS

Photosynthesis
Producer
Consumer
Decomposer
Chlorophyll
Stored Energy
Fossil Fuel
Carbon Dioxide
Oxygen
Insolation

MULTNOMAH COUNTY E.S.D. PLANT FILMS

How Green Plants Make Food - #80541
How Plants Help Us - #40728
Photosynthesis And Respiration Cycle - #80902
Plants Make Food - #40504

PHOTOSYNTHESIS AS A FOUNDATION FOR ENERGY EDUCATION

Students must first understand:

1. Carbon dioxide is taken in and oxygen is released during plant growth.
2. Oxygen is taken in and carbon dioxide is released during decomposition of plant material.

A natural direction for follow-up from the Outdoor School concepts of photosynthesis and decomposition would be toward an understanding of our common energy sources.....coal, wood, petroleum, and gas.

Students, knowing that coal and petroleum were originally plants and animals, can understand basically that photosynthesis was the process that stored the energy from the sun. This storage is often temporary.....decomposition, burning or digestion does release this energy around us continuously. However, due to the absence of decomposition, coal and petroleum are familiar examples of stored energy.

Students, without any chemistry background, understand that during photosynthesis, carbon dioxide is taken in and oxygen is released. (Figure 1) One can see that carbon (energy) remains in the plant from this process.

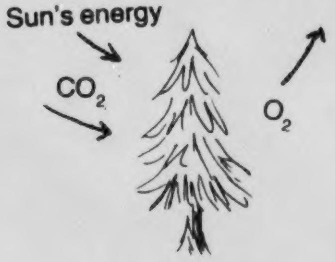


Figure 1

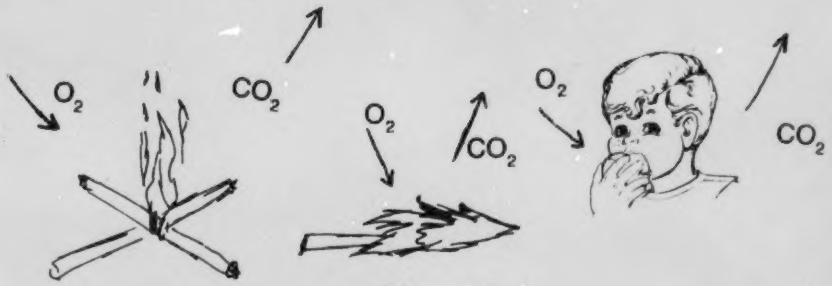


Figure 2

Fire, decomposition, or digestion

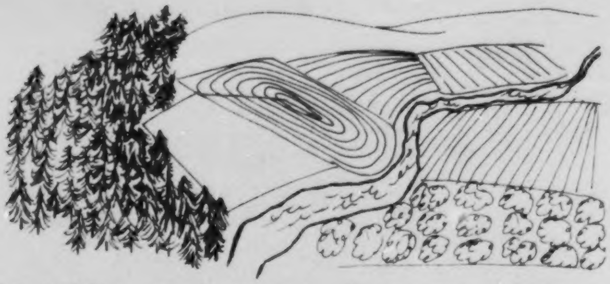
When a plant dies and decomposes, when the wood in a tree is burned, or when animals eat and digest plant food, this carbon (energy) leaves the plant material. Part of the carbon (energy) is taken in by other plants and bacteria, part becomes ash from a fire, and part is digested (burned) to become nutrients for animals and humans. Much carbon escapes as a gas (carbon dioxide) in all of these processes and enters plants and/or animals through the air to start the whole process again. (Figure 2) Coal for example, is mostly plant material which 250,000,000 years ago did not decompose. Being sealed from oxygen due to being submerged in water, sand, etc. the natural decomposing action which consumes, was halted. Since carbon dioxide was not given off, the carbon was stabilized in the coal and will remain there until it is eventually burned. Like decomposition, this energy is then released and so is the carbon in several forms, including carbon dioxide.

Note: Students can remember examples at Outdoor School and other areas where decomposition occurs under water. However, in ancient coal swamps, due to extreme acidity, compaction, and probable eutrophication, decomposition was stopped.

SOLAR ENERGY - A COMPARISON OF TWO ENVIRONMENTS

Natural Environment

In the natural environment the sun provides the energy to run the entire system. There are occasional shortages and surplus amounts of light and heat. All life in this system is a result of the sun's energy.



Self-Sufficent, Producer, Consumer, Decomposer

The natural system has been able to capture enough of the sun's energy through plant photosynthesis to maintain itself and slowly (over millions of years) accumulates a surplus of stored energy. This undecomposed wood, oil, gas, and coal reserves store energy that is now supporting the city system.

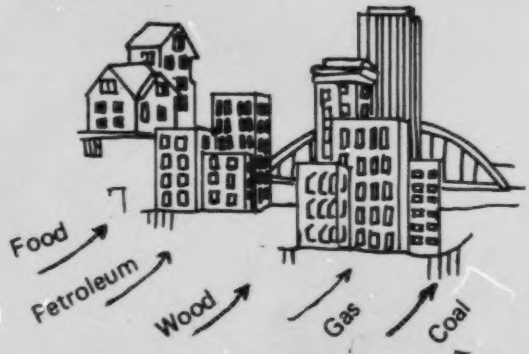
In order for a corn plant to make one kilogram (2.2 lbs.) of sugar, 4.4 kilowatt hours of the sun's energy must be consumed. This is the same amount of energy that would be consumed by a color television in fifteen hours of viewing.

Every year 42,000,000 tons of carbon are absorbed by plants. Much of this is released back to the atmosphere.

The sugar which is made by plants each year (105,500 million tons) would fill a train 30,000,000 miles long or would cover the entire railway system of the world forty times over.

City Environment

In the city environment, present day energy from the sun does not run the system. Stored energy from past plant and animal growth must then be transported to the city. Life in this system adjusts to the amount of available energy from outside the city.

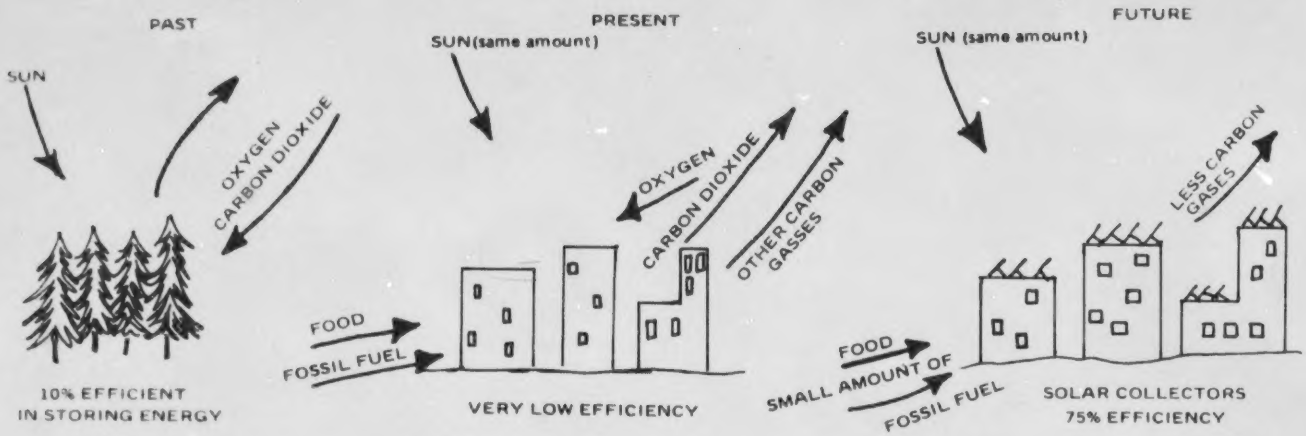


Dependent Consumer

City Environment (Continued)

The sun over the Portland area could supply a large part of our energy needs. Although the energy is here, we are collecting and using only a minute amount of it. Possibly by the year 2000, 20% of our energy will come directly from the sun.

> The city environment, for the purpose of this comparison, implies buildings, roads, parking lots, etc. and ignores the presence of city trees and lawns.
>
> Although every south facing window has some effect on energy conservation, less than 1% of Portland homes have solar installations. These installations on an average reduce their home energy use by one-half, but do not affect the energy used in our daily transportation which comprises 40% to 60% of all energy used in this area.


PAST
SUN
OXYGEN
CARBON DIOXIDE
10% EFFICIENT IN STORING ENERGY
PRESENT
SUN(same amount)
OXYGEN
CARBON DIOXIDE
OTHER CARBON GASSES
FOOD
FOSSIL FUEL
VERY LOW EFFICIENCY
FUTURE
SUN (same amount)
LESS CARBON GASES
FOOD
SMALL AMOUNT OF FOSSIL FUEL
SOLAR COLLECTORS 75% EFFICIENCY

Plants grew where your school and parking lot now exist. Although they captured less than 10% of the sun's energy, your building is capable of capturing a larger amount (75%) of the energy from the sun.

Buildings, machines, and people are not able to make food from the sun, so we rely on plants for this job. However, buildings are able to collect heat from the sun and some may not have to rely entirely on (past) plant photosynthesis for this job.

How much energy is hitting your school roof, parking lot, or lawn? For number of BTU's per square foot per day, use the table below.

For the amount of energy contacting a flat level surface:

1. Measure the area (in square feet) of floor and, to simplify, assume the roof overhead is flat.
2. Use table below to find BTU per square foot for the month of the year.
3. Divide total BTU's by 3,413 to convert answer to kilowatts received each day.

   (1 Kilowatt = 3,413 BTU)
4. 75% of this amount of energy could be collected by your building.

SOLAR INSOLATION VALUES FOR PORTLAND

Average Values For Insolation On A Horizontal Surface, BTU/Sq. Feet/Day

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
310	554	895	1308	1663	1772	2037	1674	1217	724	388	260

Conversion - 3,413 BTU/Hour = 1 Kilowatt Hour

Therefore, in Portland in January, 310 BTU's hit each square foot each day or a 100 square foot flat roof received 310 x 100 or 31,000 BTU/Day

$$\frac{31,000}{3,413} = 9.08 \text{ Kilowatts Per Day}$$

Since solar collectors can be 75% efficient: 9.08 x .75 = 6.81 kilowatts per day could be saved by capturing the energy hitting a 10' x 10' flat roof in January. This energy obviously is not collected so this heat must come from gas, oil, or electricity.

DISCUSSION TOPICS AND QUESTIONS

1. When selecting firewood, why is it best to select logs not affected by rot?

   Note: Decomposition is removing potential heat energy from the logs.

2. Compare the similarities of burning wood and burning coal. How is this process like decomposition of plant material around the school?

3. Compare this process of decomposition to our eating of food. Where did it come from? How is energy released? Can we begin to see why food is considered "burned" when it is digested? When we exhale carbon dioxide, where did the carbon come from?

4. Petroleum is unlike coal in that it occurred in a marine environment, was formed more recently, and was composed of plants as well as a large percentage of animals. Was there carbon in animals? Was there energy in animals? How did it get there?

5. What can be done to lessen the energy shortage?

   Note: Conserve, develop methods of gaining energy directly from the sun, wind, etc. and do not rely on fossil fuels.

CONCEPT

Many plants are of high economic value to man and are very important to Oregon's economy.

AT OUTDOOR SCHOOL

Understanding the measurement and the basic management of Douglas fir, western red cedar, and other trees of high economic importance is a major goal in this lesson.

Measuring the height and the diameter of a tree is a common first step when determining timber value. With these measurements and the appropriate tables, your students can determine amount of board feet. From the measurement a student can visualize one board foot, the amount of board feet in an average house, and how that volume of wood looks "on the stump". Although this type of measurement is common when selling saw logs or buying lumber, other forest products destined for paper pulp or firewood can be visualized in cords or tonnage. Your students can also see examples of potential Christmas trees, poles and pilings that require even other types of measurements. Students can see how many aspects of managing the forest, including eradicating invader plants and suppressing fire, also affect the economy.

AFTER OUTDOOR SCHOOL

Students can see as they leave the Outdoor School area and return to their homes that the value of the land is often tied to the vegetation on that piece of land. The value placed on lawns, shade trees, flowers, shrubs, garden vegetables, etc. will vary depending on the needs and standards of your students. Investigations of the plants around the school and home can include determining what is growing, why it was planted, its origin, and its value to the land owner and community.

In the school and home, students can see how Oregon forest products are used. Seeing paper, pressboard, plywood, dimensional lumber, etc. in the finished form, and remembering it in the raw form at Outdoor School, can help reinforce the importance of forestry in our economy.

OREGON FOREST PRODUCTS

We use forest products in many forms, some of which are obvious while others are totally unrecognizable in the finished form.

1. List all of the uses you have seen for whole trees and raw logs.
2. List all the uses you have seen for lumber and wood.
3. List all the manufactured items that have come from wood.

For Example:

Trees or Raw Logs

Landscaping
Poles (telephone, etc.)
Pilings (deck facilities)
Logs for buildings
Christmas trees
Firewood
Bark chips
Others?

Lumber and Wood Products

Buildings
Furniture
Sports equipment
Pencils
(And a seemingly endless list of over 5,000 other items)

Manufactured Products From Trees

Paper
Video tape
Dinnerware
Phone housings
Adhesives
Sausage casings
Electrical tape
Toothbrushes
Rocket propellants
Lamp shades
Chewing gum
Oil well drilling needs
Cosmetics
Vanilla flavoring
Baby foods
Road binders
Lube oil additives
Vegetarian foods
Vitamins
Oil spill control agents
Photo paper and film
(Over 100,000 other products)

DISCUSSION TOPICS AND QUESTIONS

1. What products are new?

2. What wood products have been or are being replaced by products made from other materials?

3. What is the source of these materials?

4. Is the supply of these alternative materials going to change in the future?

   Note: Alternative materials are sometimes oil derived plastics.

5. How does processing logs affect the value of the end product? How does processing logs into many different products affect jobs? Trade?

   Note: Refined processing involves many "steps" and people, equipment, energy, and technology at each step.

TRACING TREES FROM FOREST TO CITY

Review: Size of one board foot of lumber.

Size of a tree or trees representing 1,000 board feet.

ESTIMATING BOARD FOOT VOLUME

With the diameter and the height of a tree found, you can estimate the number of board feet of lumber it is possible to cut from the tree. One board foot is a piece of lumber 1" thick, 12" wide, and 12" long. To obtain the number of board feet in a tree, use the following table.

Board Foot Volume Table

D.B.H. Inches	Height Of Merchantable Tree In Number Of 16 Ft. Logs							
	1½	2	3	4	5	6	7	8
12	62	80	133	183	235	286		
14	64	88	147	210	274	338		
16	67	96	163	242	320	399		
18	71	109	190	280	370	459	550	701
20	75	123	221	330	435	543	651	758
22			258	383	509	633	760	884
24				438	584	728	882	1035
26					666	832	1013	1190
28					750	941	1114	1346
30					850	1062	1291	1518
32						1195	1449	1700
34						1333	1614	1898
36						1494	1782	2095
38							1955	2305
40							2150	2523

To Use: Find the tree diameter in the left-hand column labeled D.B.H. (Diameter Breast Height) inches of the tree you measured. Find the column across the top with the number of 16' logs in the tree you measured. Read the number on the table where the lines from the diameter figure intersects the log column figure. This is the number of board feet in your tree. For example, if your tree was 26 inches in diameter and had 5 logs in it, it would contain 666 board feet.

LINKING OUTDOOR SCHOOL WITH THE HOME ENVIRONMENT

GOALS

Students should be learning:

Forest and other plant products are essential in our daily lives.

Forest and other plant products generate wealth for everyone.

That plantings in urban areas become high in value and are used for many purposes.

KEY WORDS

Forest Management

Commercial Forest

Dimensional Lumber

Board Foot

Cord

Landscape

MULTNOMAH COUNTY E.S.D. PLANT FILMS

Alternatives For Oregon's Forests - #82985

Conservation And Our Forests - #80596

Conserving Our Forests - #40104

How Do They Make Plywood - #41760

BACKGROUND INFORMATION

The total land area of the state is about 61.6 million acres. And very close to half of the state is forest land. However, only 25.4 million acres of the total forest is classed as "commercial" forest, meaning land able to grow trees as a renewable crop, and available for that use.

Oregon has about 800,000 acres of state-owned forest land. Every time a stand of timber is sold from it, the profit (60% to 80%) is returned to schools and roads in the county where the timber was grown.

At the end of the 1970's Oregon had about 1.2 million acres of federal wilderness.

Oregon has the nation's largest inventory of commercial timber. It's an enormous resource....in fact, there's considerably more wood in Oregon than in all of the following states combined: Michigan, Minnesota, Wisconsin, North Dakota, South Dakota, Illinois, Indiana, Iowa, Kansas, Kentucky, Missouri, Nebraska, and Oklahoma. In the United States, one out of every five lumber trees is growing in Oregon.

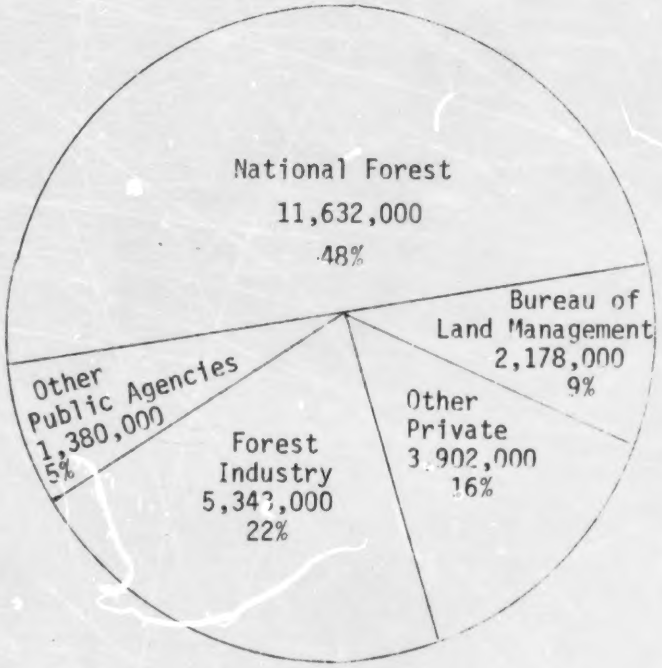
In a recent year, the value of the solid wood products manufactured in Oregon was close to $4 billion.

Some of the leading products are:

Douglas fir lumber..........	$1.5 billion
Ponderosa pine lumber.......	$500 million
Softwood plywood............	$1.5 billion

Each year the average American (man, woman, and child) uses the equivalent of a 100 foot tree.

OREGON'S
FOREST



FOREST PRODUCTS VALUE

The example below reflects actual costs of logging easily accessible, second-growth Douglas fir in the Molalla area (winter 1981).

These prices paid to owner vary greatly (i.e. $375 per 1,000 board feet for old growth logs).

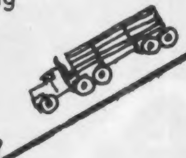
Molalla Logging Company Pays ← Estacada Sawmill Pays $260-$290 Per 1000 Board Feet To Logging Company

$140/100 Board Foot To Land-Owner

$12/100 Board Foot Falling And Limbing Trees

$58/1000 Board Foot Skidding Logs From Woods To Landing

$30/1000 Board Foot Hauling 1-15 Miles



THE RETAIL MARKET

Douglas Fir Dimensional Lumber *

1 x 2..... 8¢/ft.
1 x 4.....12¢/ft.
1 x 6.....19¢/ft.

2 x 2.....14¢/ft.
2 x 4.....23¢/ft.
2 x 6.....36¢/ft.
2 x 8.....50¢/ft.
2 x 10....60¢/ft.
2 x 12....80¢/ft.

4 x 4.....66¢/ft.
4 x 6.....93¢/ft.
4 x 8.....1.24/ft.
4 x 10....1.55/ft.
4 x 12....1.86/ft.

Window and floor molding.........26¢/ft.

* These prices from a Portland retail lumber yard (winter 1981) can be used in estimating value of lumber in the classroom or home.

BACKGROUND INFORMATION

Since students observe logs and lumber in shipment:

One self-loading log truck......2,500 board feet of logs
One log truck (average).........4,000 board feet of logs
One lumber truck (large)........18,000-20,000 board feet of lumber
........950 sheets of plywood 4' x 8'
........$35,000 worth of cedar siding
One railroad car................50,000 board feet of lumber
Record high railcar.............83,766 board feet of green Douglas fir ridge beams (181,600 pounds)

The average 3-bedroom house contains 12,000 board feet of lumber.

BACKGROUND INFORMATION - PAPER

The United States uses over ten million tons of paper annually or about 640 pounds per person.

Over 20% of this consumption comes from recycled paper.

Two tons of dry wood chips can produce one ton of pulp.

One ream of copy paper (approximately 5 lbs.) = 500 sheets.

One ton of paper = approximately 200,000 sheets.

30,000 gallons of water is used per ton of paper pulp.

5,000 gallons of water is used per ton of recycled paper.

Consumption may double in 50 years.

Newsprint accounts for 17% of our paper use:

United States.....	99 lbs. consumed per person annually
Canada............	67.51 lbs. consumed per person annually
Japan.............	41 lbs. consumed per person annually

Canada supplies 50% of our newsprint.

77 million cords of wood were used in 1976 for paper production.

There are approximately 80 cubic feet of solid wood in a cord (4 x 4 x 8 ft.)

The Northwest supplies over 15% of our nation's pulp and paper supply.

In the Northwest, over 75% of the paper produced is from lumber and plywood manufacturing leftovers.

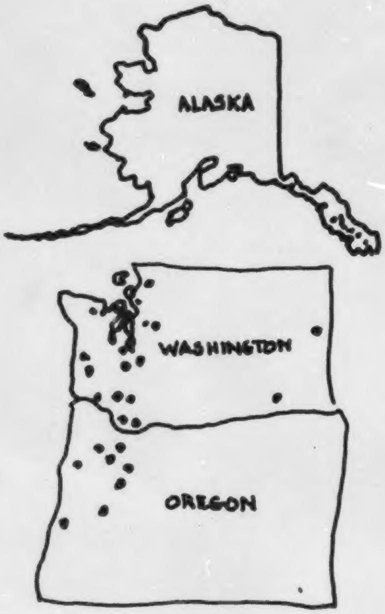
In the Northwest over 20,000 people work in the paper industry.

The Northwest's hemlock and spruce is used for high grade products such as photo film and rayon.

Pollution control from paper production has increased from $60,000,000 annually in 1969 to $300,000,000 in 1976. This removes 95% of the pollution from the air and water.

MORE PAPER INFORMATION?

The pulp and paper industry in the Northwest includes thirty-seven mills today, with almost 20,000 employees and an annual payroll of more than $405,000,000. Plant locations are shown below.



For inquiries to paper mills of the Northwest Pulp And Paper Association please use the following addresses:

Alaska Lumber and Pulp Co., Box 1050, Sitka, Alaska 99835
Boise Cascade Corp., 1600 SW 4th Avenue, Portland, Oregon 97201
Crown Zellerbach Corp., 1500 SW 1st Avenue, Portland, Oregon 97201
Fibreboard Corp., Box 489, Sumner, Washington 98390
Georgia Pacific Corp., 500 SW 5th Avenue, Portland, Oregon 97201
Inland Empire Paper Co., Millwood, Washington 99206
International Paper Co., Gardiner, Oregon 97441
ITT Rayonier, Inc., Box 539, Hoquiam, Washington 98550
Longview Fibre Co., Box 637, Longview, Washington 98632
Louisiana-Pacific Corp., Ketchikan Division, Box 6600, Ketchikan, Alaska 99901
Publishers Paper Co., Oregon City, Oregon 97045
St. Regis Paper Co., Box 2133, Tacoma, Washington 98401
Scott Paper Co., Everett, Washington 98201
Western Kraft Corp., 1300 SW 5th Avenue, Portland, Oregon 97201

LANDSCAPING - PLANTS AROUND OUR SCHOOL AND HOME

Choose a plant on your school yard or around your home and investigate why that particular plant was selected.

☐ Shade and cooling
☐ Flowers
☐ Fall color
☐ Sound barrier
☐ Wind barrier
☐ Sight barrier
☐ Food (Fruit and vegetable, etc.)
☐ Wildlife food
☐ Wildlife shelter
☐ Wildlife nesting area
☐ Soil retention
☐ Dust traps and air filtering
☐ Fence (To show land ownership, play areas, etc.)
☐ Slow grower (Under power lines, small gardens, under windows, etc.)
☐ Too steep to mow grass
☐ Summer foliage color and texture
☐ Winter sunlight (Deciduous trees chosen because fallen leaves allow winter sunlight to reach buildings.)

Draw an overhead view of your house, school, or another building and show present vegetation. What can be added? What improvements could be made?

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DISCUSSION TOPICS AND QUESTIONS

1. Why does the value of forest products increase as they move from the forest to Portland?

2. How many people get their livelihood from the harvest of the trees in the chart?

   Note: There are hundreds of direct and indirect jobs....trees generate four out of every ten jobs in the state. 95,000 directly employed by lumber and paper industry.

3. What forest products are represented in the classroom?

4. How do our different values affect landscaping? Why do we all have different values? What is the value of trees on the school property? How can landscaping be improved around the school?

5. Can we trace our own family's wealth back to Oregon's forest products?

   Note: Most family's incomes can be partially connected to our forest resource.

CONCEPT

Man has to decide between conservation, preservation, and total utilization of the plant resource.

AT OUTDOOR SCHOOL

Without exception, each Outdoor School site offers the student evidence of past logging. Large stumps can often be seen with springboard notches from the days when falling was done by hand with axe and crosscut saw. Clear cuts and second growth regeneration are also obvious at several sites. This past use of the forest and its present use as an Outdoor School site can help your students imagine other potential uses. Studying this use of the land can help in understanding the differences between conservation, preservation, and total utilization of the forest resource. Many unknowledgeable students tend to believe that a managed forest must be preserved in an unchanged condition. At Outdoor School though, students understand why certain areas are preserved while logging is a priority in many other areas. On the site, they see examples of good conservation and see that this "wise use of the natural resources" will sustain future generations. Students also see examples of poor use of the resource and can understand that lack of knowledge or lack of foresight could be reasons for this misuse.

AFTER OUTDOOR SCHOOL

When your students investigate areas beyond Outdoor School, certain questions about the conservation of plant resources can be asked. Why is the resource being removed? How is the resource being used? Can this resource be sustained in the years ahead? No matter whether that plant resource is timber, Christmas trees, or vegetables, your students should conclude that the future of both the crop and the land is more secure and predictable if the crop is handled through use of good conservation practices. We often observe that if a farmer harvests a crop of vegetables, he plants again the next year so that there will always be a crop to harvest and sell. The challenge is to understand that when a conservation-minded land owner manages land for Christmas trees or timber he or she is doing the same thing as the vegetable growing farmer, but on a different time scale.

Preservation is also a kind of land management. Examples of preservation can be found in the wilderness areas, national parks, and the preserves of the Nature Conservancy. These areas are managed to preserve their "undeveloped" pristine state, generally for unique scientific and/or aesthetic values. Students should realize that most preserved areas are not totally wild or "untouched" due to trail maintenance, fire control, and the impact of visitors.

Students should also be made aware of the in-town preserved areas such as the Hoyt Arboretum, Washington Park Rose Test Gardens, Forest Park, etc. and understand their purposes.

Depletion and misuse of resources are at the opposite ends of the spectrum from preservation. Classic examples may include: strip mining, hydraulic mining, the almost total elimination of the bison, and the poor agricultural practices that led to the Dust Bowl in the thirties. Can your students find cases of depletion or misuse of resources that are closer to home? Here the goal is to understand some of the reasons why this kind of utilization happens and project ways it might be prevented in the future.

LINKING OUTDOOR SCHOOL WITH THE HOME ENVIRONMENT

GOALS

Students should be learning:

That land value depends on the values of those who use the land.

That land is used according to the needs of the people.

That many natural resources can be managed on a sustained yield plan.

That many areas are managed to preserve their unique qualities.

KEY WORDS

Conservation
Preservation
Utilization
Wilderness Area
"Wild And Scenic River"
Park (National, State, County, City)

MULTNOMAH COUNTY E.S.D. PLANT FILMS

The Foresters - #21195
From Yellowstone To Tomorrow, Part I and Part II - #20782
Inquiry Into The American Wildland - #41242
The Missing Forest - #20511

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WILDERNESS AREAS AS AN EXAMPLE OF PRESERVED NATURAL RESOURCES

What Is Wilderness?

DEFINITION OF WILDERNESS

As contained in the Wilderness Act

SECTION 2.(c) A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

Where Are Wilderness Areas?

80% of wilderness is in national forests, 20% in national parks, National Wildlife Refuges and Bureau of Land Management areas.

How Much?

Wilderness areas total 21.5 million acres.

This is approximately equal to the state of Maine or a strip of land thirteen miles wide across the entire nation.

A Comparison

Largest wilderness area is Idaho's Salmon River area.....3,500 square miles

Los Angeles...............	464 square miles
New York City.............	320 square miles
Chicago...................	228 square miles
Portland..................	110 square miles

Largest wilderness area is 2,239,000 acres or (if square) 60 miles on one side. Portland is 70,400 acres or (if square) 11 miles on one side.

DISCUSSION TOPICS AND QUESTIONS

1. What are the reasons for reserving land for wilderness areas?
2. What problems do you feel are involved with managing a wilderness area?
3. Do you value these areas? Do you value areas that you may never visit? Why?

LAND MANAGEMENT IN THE PORTLAND AREA

7,500 acres of the city of Portland are reserved for recreational and educational purposes in one hundred sixty locations. Each area is reserved for a specific purpose.

For example:

Rhododendron Gardens - S.E. 28th and Woodstock

Washington Park - International Rose Test Gardens

Japanese Gardens - 5.5 acres of five traditional garden forms.

Hoyt Arboretum - 212 acres of identified trees.

MacLeay Bird Sanctuary - 5151 N.W. Canel Road

Peninsula Park - Sunken Rose Garden, N. Albina and N. Portland Blvd. (Largest in the city of Portland - 10,000 rose bushes.)

Forest Park - One of the largest urban parks in the nation.

Besides these areas, there are other areas in your neighborhood that serve a specific need. These areas include the following:

Lakes, ponds, and riverside parks
Fountains
Gardens
Swimming pools
View points
Natural areas and hiking trails
Sports facilities
Cultural centers
Community centers
Historical sites

What other natural areas in the Portland vicinity could be considered?

Note: There are no definite correct answers here, however, the goal should be to review or discuss familiar areas and realize the spectrum of different types of land management.

Preservation?

Examples: Mt. Hood Wilderness Area
Willamette Greenway
Sandy River "Scenic River" Area
Nature Conservancy's Comassia Natural Area (West Linn)
Oaks Bottom

Conservation?

Examples: Mt. Hood National Forest
Sauvie Island - wildlife refuge areas
State, county, and city parks
Bull Run Watershed

Total Utilization?

Examples: Farm land depletion
Strip mining
Petroleum, gas depletion

Note: Review private ownership and public ownership. Everyone has different values.....land is managed and used according to these values.

A forest ranger, a logger, a miner, a conservation club member, or the person next door, for example, might each express needs for very different kinds of land management.

What Are Your Student's Values?

Look around your neighborhood. What areas do you value the most? What makes them valuable to you?

How do you imagine our values are different from those of past years? If a natural area or park was established long ago, what values were expressed? What about the values of future generations? Will they differ?

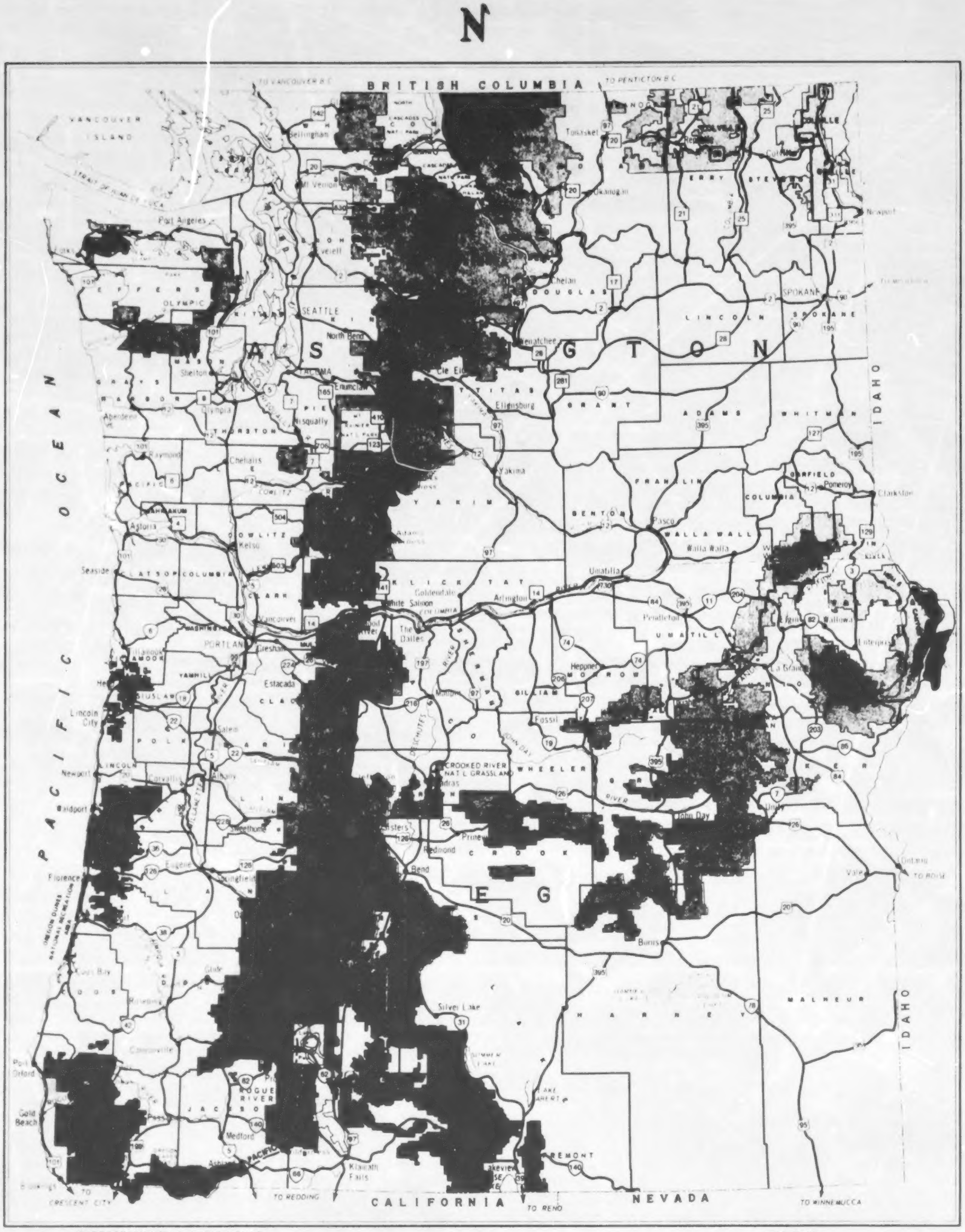
Consider quantity of reserved land and water areas that exist now. Are they adequate now? In the future?

Your students can follow-up this discussion by watching for news stories on the Columbia River Gorge, Sandy River, Boardman Boeing Land, Coastal Estuaries, Willamette Greenway.

Find an unmanaged (or undermanaged) area in your neighborhood. List as many possible uses for the area as you can.

If the class had the power to manage the area to accomplish any goals on the list, how would the group decide what to do?

Note: This is based on student values expressed earlier.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BRITISH COLUMBIA
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North Bend
TACOMA
Olympia
Aberdeen
Raymond
Chehalis
Kelso
Astoria
Seaside
Vancouver
PORTLAND
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Lincoln City
Newport
Corvallis
Albany
Waldport
Florence
Eugene
Springfield
Coos Bay
Roseburg
Glide
Port Orford
Gold Beach
Brookings
Medford
Ashland
Klamath Falls
Lakeview
Silver Lake
Bend
Redmond
Prineville
Sisters
Madras
CROOKED RIVER NAT'L GRASSLAND
The Dalles
Hood River
White Salmon
Goldendale
Arlington
Umatilla
Pendleton
Heppner
Fossil
John Day
Burns
La Grande
Elgin
Wallowa
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Walla Walla
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Clarkston
Pomeroy
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Ellensburg
Cle Elum
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TO BOISE
TO RENO
TO REDDING
TO WINNEMUCCA
TO CRESCENT CITY
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U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Scale in Miles
LEGEND
U.S. HIGHWAY
INTERSTATE HIGHWAY
OREGON STATE HIGHWAY
WASHINGTON STATE HIGHWAY
NATIONAL FOREST LAND
COUNTY LINE
WILDERNESS
PACIFIC CREST NAT'L SCENIC TRAIL

NATIONAL FORESTS
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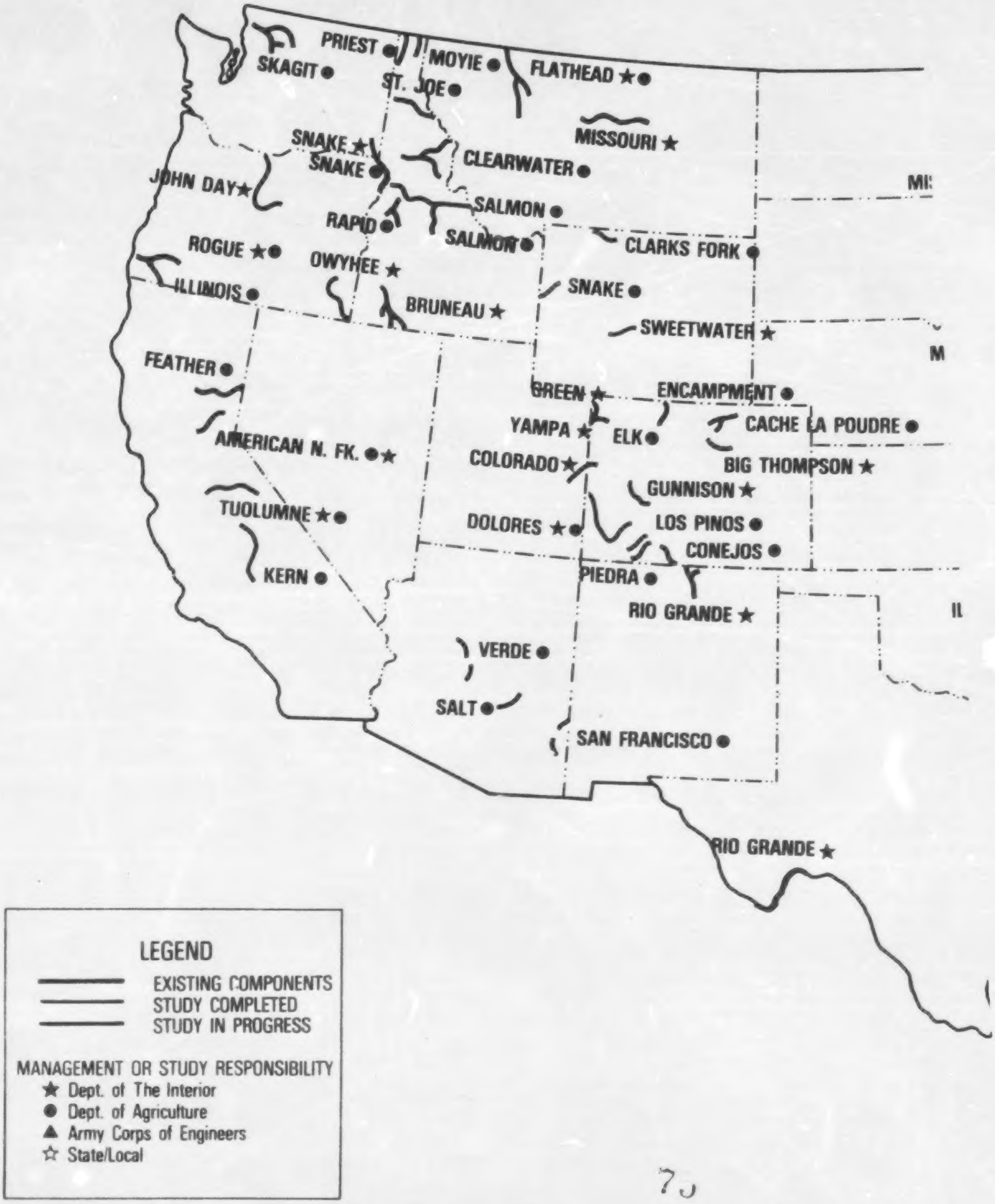
USFS R-6 1980

BEST COPY AVAILABLE

NATIONAL WILD AND SCENIC RIVERS SYSTEM


PRIEST ●
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CLEARWATER ●
JOHN DAY ★
SALMON ●
RAPID ●
SALMON ●
CLARKS FORK ●
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OWYHEE ★
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ILLINOIS ●
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GREEN ★
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ELK ●
CACHE LA POUDRE ●
AMERICAN N. FK. ●★
COLORADO ★
BIG THOMPSON ★
GUNNISON ★
TUOLUMNE ★●
DOLORES ★●
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MI
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LEGEND
EXISTING COMPONENTS
STUDY COMPLETED
STUDY IN PROGRESS
MANAGEMENT OR STUDY RESPONSIBILITY
★ Dept. of The Interior
● Dept. of Agriculture
▲ Army Corps of Engineers
☆ State/Local

CONCEPT

Conditions of sunlight, soil, and moisture aid in determining the species growing in an area.

AT OUTDOOR SCHOOL

At Outdoor School, students begin to separate the plants they see into an orderly arrangement of species that grow in specific areas due to their specialized requirements. Although it is impossible to look at all the intracacies of plant ecology, basic conditions affecting the major plant groups are understood. Overstory and understory trees, shrubs, wildflowers, ferns, fungus, mosses, and lichens are studied.

Each site has enough different plant habitats....upland, wetland, open fields, old growth, and second growth forests, etc., that students can see how varying conditions (amounts of sunlight, moisture, and soil conditions) affect the types and amounts of plant growth. Students see, for example, plants competing for sunlight. This competition, along with tolerance and intolerance to shade, are major factors that determine the kind of plants in an area. A variety of soil conditions are observed, each with an ability to grow various plants. Observation of plants growing on trees, dead logs, and rock helps lead toward an understanding of plants....soil ecology. Students also see the importance of soil and moisture and how this is linked to soil structure and texture, slope, evaporation, transpiration, and shade conditions.

AFTER OUTDOOR SCHOOL

Around the school building and student's homes, an environment has been created that in one way resembles the natural world. Although we add domestic and exotic trees and shrubs, grow vegetables, and establish lawns, we can never ignore the same factors that affect wild plants seen at the Outdoor School. Comparisons between the two areas can be made. Students must remember in the natural system, because certain conditions of soil and moisture exist, only the plants most adaptable and best able to compete grow there.

In our urban setting we manipulate many growing conditions to favor certain plants that would not survive otherwise. Students can find examples around the school where competition has been reduced, soil amendments have been added and water has been increased. The outcome of this lesson is to show that a successful planting for man's pleasure and use requires understanding of both what the site offers and the changes that can be made in order to meet requirements of the plants. No plants, wild or introduced, will grow unless these requirements are met.

CONCEPT

Free from outside interference, plants on any land area will eventually reach a point of stability (climax community).

AT OUTDOOR SCHOOL

At any site students can see evidences of plant succession....living proof that nothing is static in the natural world. Understanding succession, which is the replacement of one plant community by another, is an important step to understanding soil development, forest and land management, and plant competition. Students can perceive the consequences of fire and how other environmental changes are linked with the role of significance or many plant species.

Lichens, for example, are observed as a pioneer species living on bare rocks or tree bark where little else could live. Closer observation of rock bearing lichens show, that through chemical action, decomposition and trapping of matter, soil begins to form. As a consequence an environment is created that will suit other kinds of plants. This change continues until a climax species or stable plant community dominates the area.

Students can also see how the Douglas fir forest fits into plant succession. Looking under a stand of these trees, your students will rarely find Douglas fir seedlings, but most often will find the shade tolerant cedar or hemlock. Because of the Douglas fir's inability to reproduce in its own shade, this tree is not the climax species.

AFTER OUTDOOR SCHOOL

The different environments that can be found around the school and the neighborhood can be used to enrich your student's understanding of plant succession. They can see instances where the soil has been so disturbed that only pioneer plant species can take hold. One can see small plants growing in cracks in sidewalks where only a little sand and soil has collected, just as one sees lichens and other plants growing in crevices in rocks at the Outdoor School.

In other places, the soil remains intact, but the climax vegetation has been removed. Since the climax vegetation of your neighborhood was probably a forest similar to that of the Outdoor School area, you should be able to find various stages of succession, on the way toward climax forest. "Weeds", many of which are annual plants, are constantly moving into gardens, lawns, and cultivated areas. This is actually an early step in the process toward a climax plant community. In vacant lots one can see various stages of succession just as one can see them in abandoned farm fields. What stage has been reached will mostly be determined by how long the lot or field has been vacant.

Sometimes we intentionally hasten the natural process of succession. For instance, on trips to the coast, your students may have noticed areas where European beach grass has been introduced in order to stabilize the sand dunes. Naturally, as the vegetation of an area changes, the wildlife and soil will also change. Thus an understanding of plant succession also contributes to understanding the wildlife and soil development of a region.

LINKING OUTDOOR SCHOOL WITH THE HOME ENVIRONMENT

GOALS

Students should be learning:

That each plant type has specific environmental requirements.

The conditions that satisfy these requirements can sometimes be changed by man.

How and why man changes some conditions in order to favor certain desired plants.

KEY WORDS

Aspect
Slope
Climate
Soil Type
Soil Fertility
Plant Succession
Test Plot
Control Experiment
Shade Tolerance

MULTNOMAH COUNTY E.S.D. FILMS

How Seed Sprout - #81094
Life In The Forest - #81316
Why Plants Grow Where They Do - #40718
Wild Green Things In The City - #82387
Wildflowers - #41198
Plant Succession - #80025

ACTIVITIES TO REVIEW AND REINFORCE THE CONCEPT OF LIGHT, SOIL, AND MOISTURE'S EFFECT ON PLANTS CAN BE CONVENIENTLY SEPARATED INTO THREE AREAS

1. Classroom experiments.
2. School yard test plot experiments.
3. School and neighborhood observations.

Note: Students should understand that all experiments need a control and that only one environmental factor should be changed during each experiment.

EXPERIMENT #1 - VARYING LIGHT TO UNDERSTAND HOW LIGHT AFFECTS PLANT GROWTH

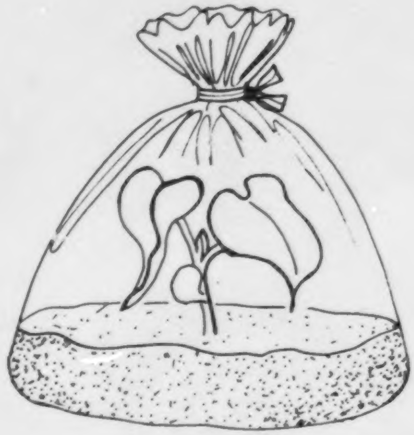
Materials Needed:

Containers	Six or more pots (for each experiment), same type and size (may be milk cartons with small drain holes, styrofoam cups with small drain holes, or peat pots). Trays or saucers.
Growing Medium	Potting soil; soil from student's home.....mixed so the entire amount is homogeneous.
Seeds	Use same kind for all plants in one experiment. Beans (mung, lima, kidney, etc.) Marigold Radish Sunflower (For large pots) Note: The larger the seed, the more stored energy it contains. Environmental changes will show less quickly with larger seeds than with smaller seeds (i.e., radish).
Water	Use same amount for each plant container on a regular schedule.
Material Source:	Growing mediums, seeds, fertilizer, peat pots, etc. suggested in these plant growth activities can all be obtained at the Multnomah County E.S.D. Living Lab (Phone 255-1841 Ex. 309).
Procedure:	Put same amount of soil in each pot. Plant one large seed or two small seeds per container. Plant seeds at same depth....according to packet directions. Place all pots in window sill an equal distance from heat. Cover pots with paper "tents" to block varying amounts of light. Observe and record results.

Note:

1. Light should not affect germination.
2. The tallest plants will generally be the ones most shaded.....closer observation will show that these do not have healthy characteristics.
3. The sunlight that aids growth also adds a negative aspect.....the hastening of the loss of soil moisture. To avoid this situation, growing a plant in an enclosed plastic bag will keep the moisture constant (see below).

A variation of this experiment involves the use of one quart or larger clear, plastic freezer bags. Place about 2" of soil in the bottom of the bag, plant a seed just below the surface and add just enough water to slightly dampen the soil. Soil collected outside in the winter would need no additional moisture. Capture as much air in the bag as possible and seal the top with a wire twist-tie or rubber band. You have created a "closed" environment that will maintain itself without further care, even over extended vacations. Growth, photosynthesis, exchange of gases (transpiration) can all be observed as well as the effect of light. Backyard soil may contain wild seeds (or spores) and amaze you with the amount of unexpected growth. Handle carefully!



EXPERIMENT #1B - LIGHT FROM ARTIFICIAL SOURCES

Procedure:

Plant seeds in same manner as first experiment.

Grow plants in flourescent light (not more than 6" away).

Grow plants in incandescent light (not more than 6" away).

Grow plants in sunlight for a "control" or comparison.

Note: Generally flourescent aids leaf growth and incandescent aids flower growth.

EXPERIMENT #1C - SHADE TOLERANCE

Procedure:

Plant seeds according to first instructions.

Plant a variety of different seeds.

Increase length of observation time because of different growth speeds.

Grow each species in full window sunlight.

Grow each species in ¼, ½, 3/4 shade.

Observe, record, and compare differences.

Note: The fact that each plant species has a different tolerance to shade is a key to understanding the main concept.

DISCUSSION TOPICS AND QUESTIONS

In the classroom experiments, why is it important to use the same size pots with equal amounts of soil?

In the classroom "light" experiments, simply moving the plants from the window sill to darker areas of the room, would be easier than erecting shade "tents" over the plants. Why was this not recommended?

Note: Moving the plant off the window sill would affect the temperature as well as the light. Experimenting with two variables at the same time would give inaccurate results.

EXPERIMENT #2 - VARYING MOISTURE

Materials Needed: Same as Experiment #1.

Procedure: Plant same species of plants in each pot.

Place pots so that they receive equal sunlight.

Vary amounts of moisture. *

Observe differences in germination growth rate and appearance.

Note: * Trial and error work prior to the "mass" planting may be needed in order to determine amount of water needed for different conditions. Be sure to always add the same amount. The plastic bag method cannot be used.

EXPERIMENT #2B - OBSERVING EFFECTS OF MOISTURE ON DIFFERENT PLANT SPECIES

Materials Needed: Same as Experiment #1, except:

Annual and perennial seeds.

Dry land and wet land seeds.

Source for dry land seeds:

Biercrest Farms, Route #2, Box 70, Zillah, WA 98953
(Sagebrush plants)

Desert Plants, 2735 E. Camelback, Phoenix, Arizona

Source for over 1,000 trees, grass, wildflowers, etc. seeds:

Clyde Robin Seed Co., PO Box 2855, Castro Valley,
CA 94546

Procedure: Plant a variety of plant species.

EXPERIMENT #2B (Continued)

Provide equal light and soil conditions. Plastic bag not usable.

Add same amount of water on set schedule....(i.e. 1 tablespoon water per day to each pot).

With second group....add less water on regular schedule (i.e. 1 tablespoon for two days to each pot).

Note results during periodic drought or wet periods.

EXPERIMENT #3 - VARYING SOIL CONDITIONS (OTHER THAN MOISTURE)

After their experience with the first two experiments, the class should be able to plan and carry out their own experiments on soil conditions. Many factors can be varied to affect plant growth.

Maintaining sunlight and moisture:

Vary texture (amounts of sand, clay, and silt).

vary structure (i.e. compact soil vs. untrampled soil).

Vary soil amendments (nitrogen, phospherous, potash, etc.).

Vary soil pH (to acid soil add lime in various amounts).

Vary soil from different areas and depth (i.e. subsoil from building projects).

Vary soil temperature.

Vary amounts of volcanic ash in soil.

Now experiment with different seeds. Observe and record the difference.

Note: All of these conditions created in the classroom exist in the natural world. Experimenting with isolated factors and different plant types reinforces the main goal....that each plant has different requirements and different environmental conditions exist that favor a variety of plant types.

In the schoolyard, students can observe varied growing conditions by observing "test" plots of existing lawn. Using 3' x 3' plots compare:

Compact vs. untrampled

Shade vs. sunny

Irrigated vs. dry

Low pH vs. high pH

Vary amount and timing of essential nutrients.

NEIGHBORHOOD OBSERVATIONS

Plant growth:

near buildings with north, south, east, and west exposures;
on varying slopes;
on construction sites;
in garden areas;
under shade trees;
heavy foot traffic areas.

How are we affecting plant growth negatively; positively?

Why do we want to change conditions that influence plants?

DISCUSSION TOPICS AND ACTIVITIES

Plant Competition

Who can grow the largest, healthiest plant?

After experimenting with different soil, light, and moisture conditions, have each student grow a bean or sunflower plant (same seed source) giving him/her complete freedom of choice of soil, light, temperature, etc. in the classroom.

Since environmental conditions such as light, moisture, and soil influence plants without man's interference, why is it important to understand this?

> Note: Since we favor some plants over others, we can change the growing conditions in favor of the desired plant.

What plants do we favor?

> Note: Agricultural crops rather than weeds and brush.
>
> Certain trees such as Douglas fir over alder, grand fir, etc.
>
> Lawns and exotic landscape trees over weeds and brush.

How do we change conditions to increase our favored plant's chance of success?

> Note: Irrigate lawns and farm crops.
>
> Decrease competition and increase light by weeding, spraying selective herbicides, thinning forests.
>
> Increase soil fertility by fertilizing forests, farms, and lawns.
>
> Change pH to more alkaline condition by adding lime to farm lands and lawns.
>
> Change soil texture by adding sand and humus to dense soils.
>
> Encourage better drainage and higher soil temperature by planting on mounds.

CONCEPT

Plants can be classified by similarities and by differences.

AT OUTDOOR SCHOOL

On each site, students can find representatives of each of the major plant groups and understand the basic procedures in identifying selected species. Identification is less puzzling when your students look for the unique characteristics that distinguish one plant from another. By using field guides or "keys" students understand how to separate a large number of different plants into smaller and smaller groups that have similar (or different) characteristics. The goal then, is not to commit to memory all the plants at the site, but to understand this classification procedure.

Representatives of the major plant groups found at Outdoor School include several important timber trees. Students see Douglas fir, western red cedar, hemlock, and on some sites, true fir. They recognize the differences between deciduous and coniferous trees. Shrubs, mosses, ferns, lichens, fungi, and herbacious plants are identified and studied as well.

Students often express an initial interest in learning about edible plants. However, they soon learn how complicated exact identification can be....especially when dealing with the growth stages of mushrooms which many times even confuse the experts. One goal, therefore, of this lesson is to discourage tasting these plants.

If students collect plants, or parts of plants, to take back to school, they learn the importance of using proper procedures, using plant presses, or making terrariums. They will find that, in most cases, they can take leaves from a tree and do no harm at all, while in other cases, a plant (such as the ghost orchid) may be so rare that it should never be disturbed. Students may then gain not only an understanding of plant collecting, but also an understanding of rare and endangered species.

AFTER OUTDOOR SCHOOL

For many of your students, becoming familiar with the major trees, shrubs, and other plants at the Outdoor School can be the beginning of a lifelong interest. Plant collections, like rock or insect collections, are usually a first step in developing a working knowledge of the subject.

Knowing the correct name helps a student communicate about the plant, and seek for example, additional knowledge about its relationship to other plants and animals.

An on-going plant collection for the whole class can be a valuable teaching tool. Precautions concerning rare or poisonous plants are, of course, necessary. Although there are many sources readily available for proper identification, no expert or field guide can help if the plant has not been properly pressed or if field information has not been recorded by the collector. Classifying plants in the urban setting can be challenging because introduced (exotic) nursery stock is often mixed in with Northwest plantings. When identified, these plants can be an excellent springboard for additional learning about the plant's native environment.

LINKING OUTDOOR SCHOOL WITH THE HOME ENVIRONMENT

GOALS

Students should be learning:

Names and categories of plants are an essential tool for communication and further investigation.

Plant keys are a valuable and commonly accepted method for identification.

Plant collections can act as a resource library for inspiring interest and further study.

That laws to protect plants as well as the landowner are necessary and preliminary to plant collecting.

KEY WORDS

Deciduous

Coniferous

Key

Flowering Plant

Non-flowering Plant

Alternate Leaves

Opposite Leaves

Simple Leaves

Compound Leaves

MULTNOMAH COUNTY E.S.D. PLANT FILMS

Conifer Trees Of The Pacific Northwest	#80165
Learning About Leaves	#81310
Tree Portraits	#20095
Classifying	#80284

THE CLASSROOM PLANT COLLECTION

One on-going classroom plant collection may be more beneficial than the more complete university collections. This smaller collection can focus on plants in the immediate neighborhood or school, can be easily accessible, can be assembled over time....selecting and focusing on a specific area or kind of plant.

Learning happens when students are:

deciding what to collect;

understanding laws concerning rare plants and land ownership;

gaining permission to collect;

preserving the plant;

gathering information for the label;

researching additional details;

realizing that each species is recognized as a component to the workings of the entire natural system.

One important element of plant identification is pointed out by Comstock, an early forerunner in environmental education. Her suggestion of looking at specific parts of a plant or animal for clues to its identification, etc. is important and also greatly simplifies the investigation. This also helps students to better understand the purpose (i.e. adaptation) of the parts of a plant.

> "The object lesson method was introduced to drill the child to see a thing accurately, not only as a whole, but in detail, and to describe accurately what he saw. A book or a vase or some other object was held up before the class for a moment and then removed; afterwards the pupils described it as perfectly as possible. This is an excellent excercise and the children usually enjoy it as if it were a game. But if the teacher has in mind the same thought when she is giving the nature study lesson, she has little comprehension of the meaning of the latter and the pupils will have less. In nature study, it is not desirable that the child see all the details, but rather those details that have something to do with the life of the creature (plant) studied".
>
> Anna Botsford Comstock, 1911

THE PLANT KEY

This activity involves students as a preparation for developing a plant key. It is an aid for students in:

developing their own key for identifying plants;
using an already established key for plant identification.

A way in which we learn about our world is in recognizing differences between and among things. We tend to take such differences for granted, or not see them at all.

To be able to see differences we often must sharpen our ability to observe closely. If we have a large number of objects and are trying to find out their differences, we find a need for classifying them in some way. We might separate them by size, or color, or what they are used for, or weight, or texture, or structure, or by some other measurable means.

This type of classifying is called Dichotomous Keying ("di" refers to two, and "chotomous" refers to branching....or two-branching keying). It is used very widely in animal and plant identification, and can be used for classifying many other type of objects.

List any six children and their characteristics on the board in list form. Help the class create branching key.

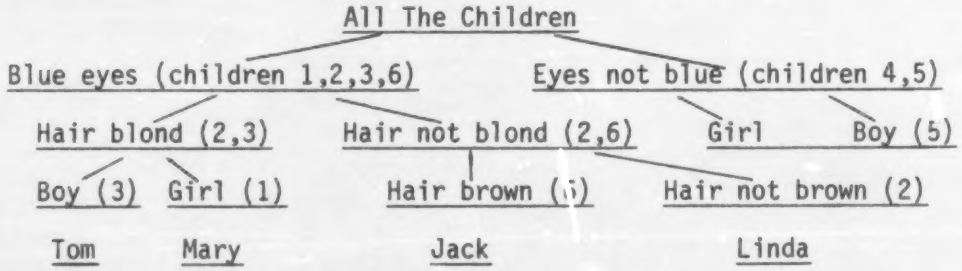
Children

1. Mae...blond, blue eyes
2. Linda...red hair, blue eyes
3. Tom...blond, blue eyes
4. Joan...blond, grey eyes
5. George...black hair, brown eyes
6. Jack...brown hair, blue eyes

Explain

A key can start with any difference that allows grouping into two groups. We could make the first branching as boys and girls; or the first could be blue eyes and eyes not blue; or it could be hair blond and hair not blond; or it could be some other characteristic. It does not matter at all what each branching is, provided that it clearly separates the samples (here the children) into two distinct groups.

Illustrate key as students make suggestions. The key may look like:



Now, the same process can be repeated by distributing six plant specimens. This key then can be a foundation for plants of the entire school yard.

FIELD COLLECTING

Check around the area to be sure there are many plants of the same species remaining.

Although botonists use a metal "vascula", plastic bags in a cardboard box will do for temporary storage until plants are pressed.

Every plant collected should have complete information recorded on it. Below is a typical field label.

FIELD LABEL

1. Name.....................
2. Exact Location...........
....
3. Associated Species.......
....
4. Soil: Type and Moisture..
....
5. Exposure................
6. Elevation...............
7. Height..................
8. Flower Color...............
9. Habit of Growth............
10. Abundance..................
11. Remarks....................
....
12. Collected by...............
13. Date.......................
14. Number.....................
15. Identified by..............

PLANT PRESSING - HELPFUL HINTS!

1. A speciman too small or otherwise atypical should be avoided.
2. Include fruit or flower if possible.
3. Mounting paper sold in biological supply companies can assist.
4. Absorbent paper (newspaper) and corrugated cardboard can be used.
5. Delicate plants require only a few days if press is placed in a sunny or warm spot. Others may require several weeks!
6. Do not overlook twig collections, contact paper.....plant collections, and living plant collections.

NEIGHBORHOOD TREES

The following trees and shrubs easily observed from the streets in the Portland area are examples of the largest or best specimens that could be found at one time. This list is only a beginning and certainly can be expanded and updated so that some day your school neighborhood will serve as an arboretum.

PONDEROSA PINE (LAWSON)
Hoyt Arboretum

WESTERN SYCAMORE
SW Park and Main

BALSAM POPLAR
35 SE 32nd Avenue

JAPANESE FLOWERING CHERRY
2444 SW Broadway Drive

DOUGLAS FIR
240 SE 53rd Avenue; Laurelhurst Park; MacCleay Park

PEAR
Lloyd Center; 2400 NE 32nd Avenue

RED OAK
5700 SE Taylor; 4775 SE Stark; 6824 SE 34th Avenue; 5830 SE 41st Avenue; Milwaukie Library; Eastmoreland Gold

SCARLET OAK
5700 SE Oak Street

SILK TREE
2308 NE 50th Avenue; 2140 NE 26th Avenue; 3463 SE Ash Street; Mt. Tabor Nursery

MONKEY PUZZLE TREE
9430 N Ivanhoe; 9008 N Charleston; 905 SE Lexington; 34 SE Gladstone; 39 SE Clinton; 34 SE Hawthorne; 5831 SE 41st Avenue

MAPLE PURPLE LEAF
3121 NE Thompson Street

SUGAR MAPLE
2857 SE Carlton; 5805 SE 40th Avenue

BOX ELDER
6812 SE 30th Avenue

BIG LEAF MAPLE
Sauvie Island near Bybee-Howell House

AMERICAN CHESTNUT
4915 SE Stark; Elk Rock Island Custer Park; 5109 SE Stark Street

PECAN
SE 35th and Gladstone; Lair Hill Park

CATALPA
1334 SE Tacoma Street

RED BUD
3043 SE Carlton; 1215 SW 14th Avenue; Sauvie Island; West Road

DEODAR
5019 SE Stark Street; 2851 NW Cumberland Road

ATLAS CEDAR
4775 SE Stark Street; 1225 SE 60th Avenue; 1425 SW 20th Avenue; 5830 SE 41st Avenue

PORT ORFORD CEDAR
8012 SE 7th Avenue; 72nd and Stark Street

EASTERN DOGWOOD (Variant)
4306 NE 41st Avenue; SE 39th and Knapp; Rhododendron Island

WEST COAST DOGWOOD
3580 NE Killingsworth; 102 NE Beech Street

BLACK SPRUCE
1425 SW 20th Avenue; Pioneer Court House; Art Museum

NEIGHBORHOOD TREES (CONTINUED)

OREGON WHITE OAK
7126 SE 13th Avenue; Oaks Park; Willamette Park

PIN OAK
SE 37th and Carlton; 2825 SE Tolman; 3527 SE Ash Street

REDWOOD
816 SW Vista (17' 4" cir.)
816 SW Vista (14' 6" cir.)

GIANT SEQUOIA
1225 SE 60th Avenue (18' 2" cir. 80 yr.)
5810 SE Taylor (17' 2" cir. prior 1908)
816 SW Vista (16' 10" cir.)
816 SW Vista (16' 2" cir.)
3108 SE 29th Avenue (16' 9" cir.)

MOUNTAIN ASH
200 N Vancouver

AMERICAN ELM
Y.W.C.A Court Yard, 10th and Main

OREGON MYRTLE
7855 SE Milwaukie (3 trunks, 3" diameter)
SE 32nd and Holgate Blvd.
SE 27th at 7156
9542 N Ivanhoe (18' 24" diameter)

CYPRESS
3243 NE Wasco; 2103 SE Stark Street; 7020 SE 32nd Avenue

PERSIMMON
NE 7th and Hancock (brought by John Bacher from 1917 San Francisco Fair)

RUSSIAN OLIVE
2349 NE 16th Avenue; Center North, Grant Park

EUROPEAN BEECH
Hoyt Arboretum; 214 SW Marconi; NE Going and Garfield

HONEY LOCUST ("SUNBURST")
30th to 31st on SE Pine Street; 3939 SE 26th Avenue; 45 SE Henry

GINGKO
Powell Park; Washington Park; Plaza Blocks; Leach; 1425 SW 20th Avenue; 662 NE Melinda; Holladay 6th and 7th; Lloyd Center (largest); SE 25th and Hawthorne (tallest)

BLACK WALNUT
1441 N McClellan (Interstate Highway Office); South Park Blocks

LARCH
8024 SE 8th Avenue

INCENSE CEDAR
1145 SE 55th Avenue; 8602 N Woolsey; 1323 SE Carlton; 5830 SE 41st Avenue

SWEET GUM
60 SE Salmon; Cornell Road and NE Northrup Street; NE 22nd and Brazee; 2617 NE 16th Avenue

TULIP TREE
3104 SE Gladstone; 60th and Salmon; 2011 NE 47th Avenue; 2390 SW Madison; Milwaukie Library; Leach Park; 5830 SE 41st Avenue; 2418 NE 31st Avenue; 1431 NE Weidler

BLACK GUM
Laurelhurst on south side, opposite 3604 SE Oak Street; Sellwood Park on East Side Center

SOURWOOD
4305 SE Raymond; 2204 SE 35th Place

COLORADO BLUE SPRUCE
2105 NE 28th Avenue; 720 NW Warrento Terrace; NE 7th and Hancock; 5231 SE Lincoln Street

CONCEPT

Different habitats possess characteristics which allow certain types of animals to develop. An animal's adaptation is a direct result of, and tied to, its habitat.

AT OUTDOOR SCHOOL

Your students can investigate a variety of animal habitats on any of the Outdoor School sites. Deciduous forest, open meadows, both young and old growth conifer stands, are all habitats for a variety of animals. Both the deer habitat, which may be many acres in size, and an insect habitat, which may be a small part of a rotten log, offer the vital necessities....food, water, shelter, and a place to propagate young.

The sum total of environmental conditions in a certain area determines what organisms may live there. Your students will understand, as they explore Outdoor School, that they are moving through a variety of habitats. These habitats are obviously constantly changing. A key in understanding the link between an animal's appearance and its habitat becomes easier to understand when one sees the variations among a certain kind of insect, bird, mammal, etc. The individuals of a certain species best suited to the habitat, survive and pass on their traits to their young.

An important concept is that animals have varying abilities in adapting to change in their habitat. The coyote, whose tracks are often seen by your students, is an example of an animal which is flourishing and broadening his range due to its ability to easily adapt to change. However, decreasing habitat is probably the single most crucial factor in wildlife loss. At Outdoor School, the habitat has changed greatly from the original old-growth Douglas fir forest. Now, we find that scattered clearings, alder or hazel thickets, and patches of second growth timber are more the rule. In general, this variety in habitat brings about decreases in some populations of animals while it has helped others. For example, the student's chances of seeing deer are greater now than when Lewis and Clark came through this area. Deer adapt very little to change. They avoid heavy forest, but find abundant food in brushy areas. Man has changed the plant growth on the land and unintentionally met the requirements of the deer. From this lesson, your students can gain an appreciation that the professional wildlife manager must become concerned with wildlife habitats if he is to manage wildlife of any kind.

AFTER OUTDOOR SCHOOL

The Outdoor School is an excellent place to learn about animals in that particular area, but an impossible place to study the harp seal, the prairie chicken, or the bighorn sheep. However, the natural laws that govern the animals found at Outdoor School are the same ones that govern species around the world. Through a review of these "basics", students will have the tools to understand animals wherever they go. When studying any animal....wild, domestic, or classroom, its habitat must be studied as well. Where did the animal come from? What does it require from its habitat? Does it appear to be an animal that can adapt to other conditions? What is the condition of its present habitat? If the habitat is being changed, what are the reasons for this change? Are there other animals that may compete because of introductions, expanding range, etc? Are there new habitats that may supply all the essentials for a certain animal? A classic answer to this last question is the example of the chukar partridge which was brought from Asia and released in eastern Oregon.....it is now flourishing in a habitat similar enough to its faraway home to allow it to survive.

By understanding wildlife adaptation and relationship to habitat, we can better understand our own relationship to habitat. Even though human beings have the greatest ability of all to adapt, we are never independent of the same basic needs as animals....food, water, shelter, and a secure place to raise our young. On the other hand, humans perceive their needs on a plane far above that of animals and strive for an even higher standard of living. As our human populations grow and our material desires expand, this inevitably impacts our own habitat and the habitat of all animals. It appears that sooner or later humans must consider some trade-offs if they are to survive on a crowded planet.

LINKING OUTDOOR SCHOOL WITH THE HOME ENVIRONMENT

Goals

Students should now be learning:

How urban students affect animals and their habitat outside the Portland area.

About urban wildlife and urban wildlife habitat.

How adaptation and habitat are tied together.

KEY WORDS

Habitat

Adaptation

Niche

MULTNOMAH COUNTY E.S.D. ANIMAL FILMS

Adaptation For Survival Birds - #80328

Adaptation In Animals - #80625

Adaptations Of Birds - #14696

Animal Camouflage - #43327

Animal Habitats - #40558

Animals In The City - #41224

Bighorn - #20934

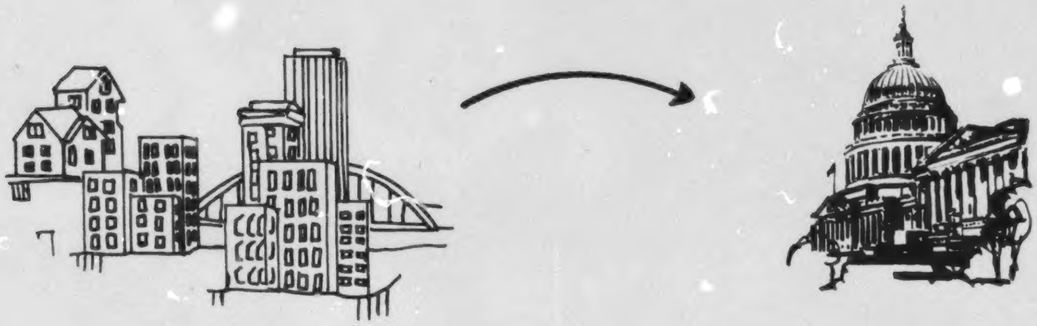
Birds That Hunt - #42080

Conservation And Balance In Nature - #80919

Wild Dog Family The Coyote - #80501

HOW DO PORTLAND AREA RESIDENTS AFFECT WILDLIFE?

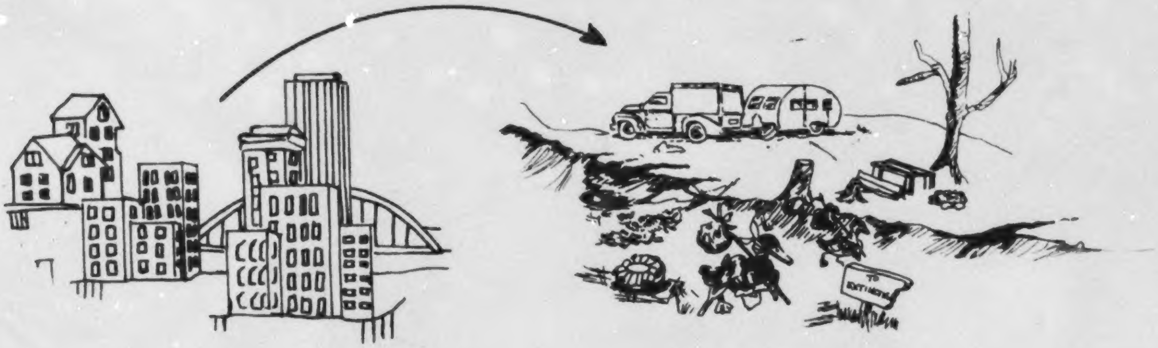
VOTING



During elections we influence wildlife and wildlife habitat. Elected officials, representing the views of the majority, are continuously making laws and appropriating money that may positively or negatively affect wildlife.

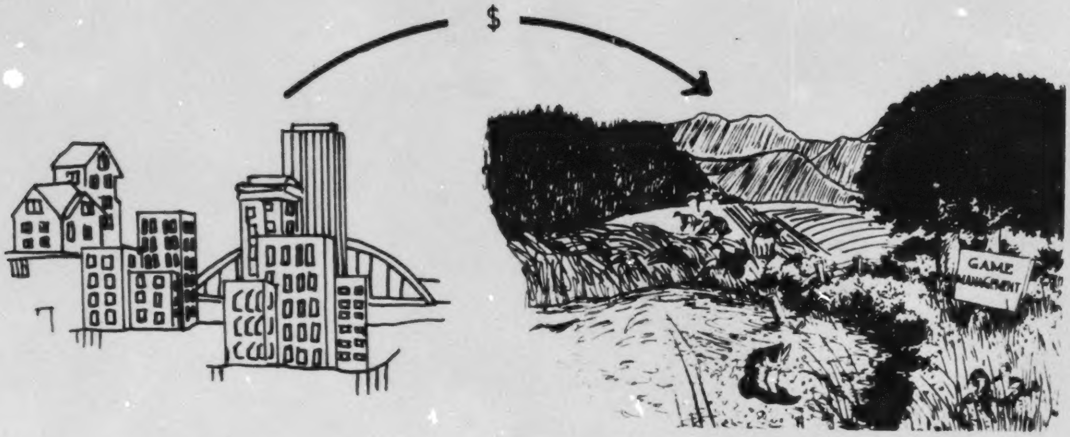
....

DIRECT IMPACT



Residents of the Portland area cause impact on surrounding wildlife and habitat. In Oregon, nine out of ten people engage in some kind of wildlife oriented activity. For example, in 1970 in the United States there were 6.8 million bird watchers, 9.5 million wildlife photographers, and 27 million hikers. Their days in the field total more than 786 million! The Mt. Hood National Forest received 4,154,300 visitor days of recreational use last year. How many days did your students visit this forest? Did they cause positive or negative impact?

MONEY



Licenses In The United States

Fishing Licenses - 28,000,000)
Hunting Licenses - 16,000,000) $418,000,000 For Wildlife Nationwide

Licenses In Oregon

Fishing Licenses - 630,000 ($9.00 per license) = $5,670,000 Annual Total
Hunting Licenses - 244,000 ($7.00 per license) = $1,708,000 Annual Total
Combination Fishing
and Hunting - 173,000 ($15.00 per license = $2,595,000 Annual Total

License Money For Oregon Wildlife Management $9,973,000 Approximate Total

Since the population of Multnomah County is 562,000 and approximately 40% of the population (statewide) hold a fishing or hunting license, $2,000,000 flow from the county residents to wildlife annually.

Another source of money going from Oregon to wildlife is federal waterfowl stamps ($5.00 each); 54,657 sold to Oregon hunters as an additional permit for waterfowl hunting. This money goes to maintain the federal waterfowl refuge system. Nationally it has raised over $210,000,000 since it appeared in 1934, paying for over 2,300,000 acres of waterfowl habitat.

Excise Tax.....From Sporting Goods Sales Help Support Wildlife

(The nation's 21,000,000 hunters are spending more than $12 billion annually on this sport.)

10% on fishing equipment = $33,000,000 annually; $791,000 to Oregon fish.

11% on archery equipment = $ 6,000,000 annually.

11% on firearms (excluding pistols) = $40,000,000 annually.

10% on pistols = $22,000,000 annually.

11% on ammunition = $33,000,000 annually.

Excise tax on hunting and fishing equipment reaching Oregon = $2,056,000.

Contributed Money

$200,000 for Oregon litter pickup from sale of personal auto license plates (1974).

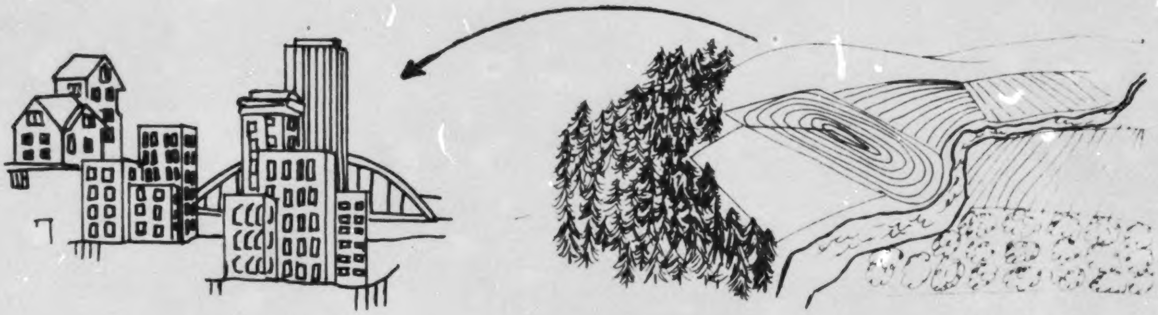
$345,000 to Oregon State Watchable Wildlife Fund. *

$22,000,000 has been donated nationally to Ducks Unlimited since 1937 to develop and maintain waterfowl breeding areas in Canada, the source of 65% of the waterfowl in this country. Being on a major flyway, Oregon benefits greatly as birds migrate south each fall.

National Wildlife Federation, National Audubon Society, etc. and hundreds of other organizations helping wildlife through personal contributions.

Note: * It is important to clarify that this money goes for the assistance of nongame or animals not hunted. "Game management receives most of the tax and license money listed above because the money generally comes from the hunter."

USE OF NATURAL RESOURCE PRODUCTS



In living in the Portland area our own needs, our standard of living, and our life style may be at the expense, unintentially, of wildlife and wildlife habitat.

Consider Our Needs For:

Electricity.....loss of free-flowing rivers and fish habitats.

Fur apparel.....reduction of fur-bearing animals such as the harp seal and snow leopard are well known. However, many fur bearers are raised on fur farms at no loss of habitat or demise of the species. Still other "wild" fur bearers and their habitat are quite stable, being managed and perpetuated by the money (licenses, etc.) from the trapping.

Exotic pets.....many animals, because of their rarity, are collected for the pet trade. Many times this increases the rarity and the demand at the same time.

Food.....since wildlife and agriculture many times share the same land, certain crops and farming methods can affect wildlife.

Lumber.....loss of old growth forest reduces some wildlife populations and enhances others. For example, loss of old snags, common in old growth forests, reduces potential homes of forty-three birds and nineteen mammals. Reducing old growth conversely makes better deer habitat and dramatic increases in their numbers. It has been reliably estimated that there are five times as many deer in Oregon now as in Lewis and Clark's time, primarily due to removal of old growth forest and the influx of brush species into the vast logging areas.

Population.....more people spells loss of wildlife habitat, both at the new housing sites and at the sites that produce needed products. Human recreation demands much land and produces impact.

What Else?

Make a list of products that your students have purchased recently. How have they indirectly affected wildlife and wildlife habitat?

AFFECTING WILDLIFE AROUND OUR HOME AND SCHOOL

Developing A School Yard Wildlife Habitat Is One Method Of Increasing Urban Wildlife

This may be a single tree or several hundred square feet of trees, shrubs, and flowers to attract and hold wildlife.

Advantages of:

1. Planning and mapping site.
2. Site preparation.

   Analysis of soil.....

   structure and texture
   fertility
   slope and aspect

   Possible soil amendments.....

   correct amount and timing
3. Understanding potential wildlife that may use the area.

   Identifying species.

   Feeding adaptations.

   Wildlife feeding habits and preferred food.

   Population and carrying capacity.

   Limiting factors.

   Wildlife need for cover and nesting.

   Territories.
4. Plants.

   Understanding of specific plant's needs....soil, light, water, etc.

   Specific seeds, berries, flowers, etc. provided by each plant and time of year this food is available.

   Considerations involving introduced species.

   Planting techniques.

   Maintenance.

For additional information send for:

"Invite Birds To Your Home", Soil Conservation Service (Aid 1094)

"Invite Wildlife To Your Backyard", National Wildlife Federation

DISCUSSION TOPICS AND QUESTIONS

1. From a list of animals observed at Outdoor School, discuss how each is dependent upon its habitat. What special adaptations do each of these animals possess to suit them for this habitat?

2. Your school and neighborhood is a habitat for certain animals. Which of these are also found at Outdoor School? What do these two habitats have in common? Which animals are found only in the neighborhood? Which animals are found only at Outdoor School? Why?

3. Choose one animal that was found only at Outdoor School, but not in the neighborhood. What changes in the habitat would have to be made in order for that animal to survive here?

4. Some species of animals adapt very quickly and easily to habitat change and others do not. What factors help determine whether an animal is easily adaptable to varying conditions? Consider for example, the coyote, waterfowl, opossum, rat, English sparrow, crow, starling, etc.

   Note: That is, nesting requirements, number of young, food requirements, etc.

5. If a habitat is improved for a certain animal in your neighborhood and the population still does not increase, what other factors can be considered?

6. What adaptations do humans have for survival? What habitat needs do we require? Do you think humans adapt easily to change or not? Are we locked into the same environmental factors that govern wildlife populations?

7. Can you think of some native animals whose population has increased as a result of man's changes in environment? (Deer population, field mouse, various songbirds.)

8. Concerning direct impact, what negative influence have area residents had on the surrounding area?

   Note: Illegal hunting, traveling into closed areas that affect wildlife nesting, migration, and raising of young, etc. Destruction of habitat using off-road vehicles, abandoning pets in the wild, capturing and taking animals for pets, excessive noise, pollution and littering, starting wildfires, feeding animals in the wild.

CONCEPT

The removal of a species from a habitat or the introduction of exotic ones may give rise to imbalance.

AT OUTDOOR SCHOOL

Knowing about the "web of life" or briefly, the dependance of animals on other animal species and plants for food, shelter, etc., your students can project that the introduction or removal of a species may have an effect on this web. At Outdoor School students are often able to observe some of the changes that may have been caused by an introduction of exotics or removal of native species.

All of the Outdoor School sites are inhabited by the opossum, a good example of an unwanted transplant that is causing widespread damage. Students may also have a chance to see or hear the ring-necked pheasant which is the best known and most successful game bird transplant in this country. Plant introductions by unthinking people are numerous in the state. On-site your students will usually see Scotch broom and evergreen and Himalayan blackberry choking out native plants that have value in the natural system and the food web.

Your students should also understand from animal study at Outdoor School, that many times the first animals to be reduced in numbers are those on top of the food pyramid (predators). This is true in Oregon of the grizzly bear and the wolf. It is often difficult however, to see how their absence has affected the food web and other animal populations. These effects could be offset due to human caused factors such as habitat change and managed hunting. Understanding some of the reasons for these reductions and the effects on the remaining animals and plants is part of this lesson.

AFTER OUTDOOR SCHOOL

In review, it is important that students realize that the introduction of or transplanting of animals can happen legally by the state or federal wildlife agencies, or illegally by unknowing people. Any student has the potential for introducing an animal that may have as much detriment to the environment as the opossum, starling, or carp. Unfortunately, many of these animals can be purchased inexpensively at local pet shops.

Probably the most harmful introduction to the wild is the domestic cat. Unlike most dogs, they revert quickly to their natural instincts and may reproduce and live for years feeding on songbirds, gamebirds, young squirrels, and rabbits.

Students can also investigate endangered, threatened, and extinct species. Possibly because this subject is well publicized and dramatized, a common misconception among students is that hunting, trapping, or even insect collecting are stepping stones to extinction. Looking into the causes, one will generally find that habitat reduction by humans is the major factor. Additional follow-up study can help the students fully understand the cause of these problems.

LINKING OUTDOOR SCHOOL WITH THE HOME ENVIRONMENT

GOALS

Students should be learning:

The positive and negative aspects of animal introductions.
The significance of, and reasons for declining animal populations.

KEY WORDS

Endangered Species
Extinct Species
Threatened Species
Introduced Species
Exotic Species

MULTNOMAH COUNTY E.S.D. ANIMAL FILMS

American Bald Eagle - #81127
American Buffalo: The Comeback - #40617
Keepers Of Wildlife - #81938

DECLINING ANIMAL POPULATIONS

ENDANGERED ANIMALS AND PLANTS (1981 U.S. FISH AND WILDLIFE SERVICE)

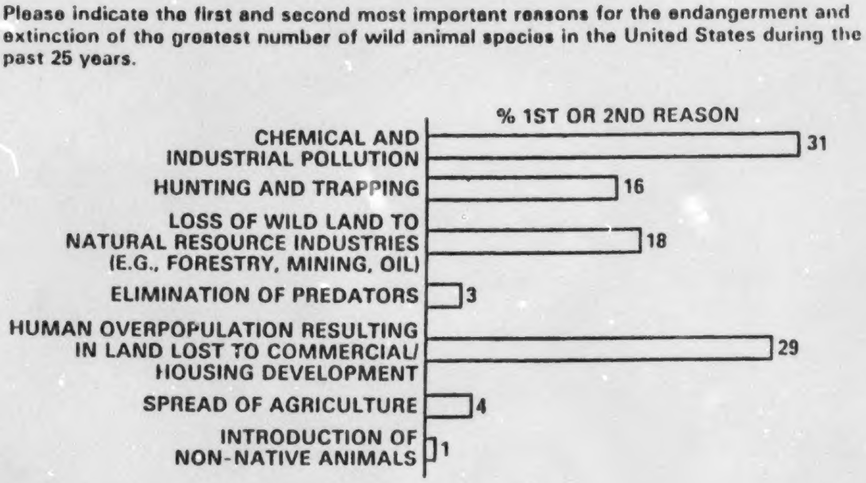
	United States	United States & Foreign	Foreign
Mammals	5	17	224
Birds	52	14	144
Reptiles	7	6	55
Amphibians	5	0	8
Fish	29	4	11
Snails	2	0	1
Clams	23	0	2
Crustaceans	1	0	0
Insects	7	0	0
Plants	48	2	0

What are some of the reasons that may cause a particular animal to become extinct?

On a recent survey over 3,000 people were asked the following:

CAUSES OF ENDANGERED SPECIES

The
Answers
Were:



These opinions do not reflect the true situation......

> 75% of the animals on the endangered species list are there because of loss of habitat.
>
> 25% of the animals on the list are losing numbers due to pollution, introduced species, man-made structures, and natural causes.

BACKGROUND INFORMATION

There are 3,500 to 4,500 mammal species in the world. 380 are found in North America (United States and Canada); 35 are hunted; 37 are endangered.

There are 8,600 bird species in the world. 650 are found in North America; 74 are hunted; 66 are endangered.

Coincidentally, the numbers of endangered and hunted animals are close. However, the 35 species of mammals and 74 species of birds that are legally hunted in the United States and Canada are in no danger of becoming extinct or endangered. Because of management involving bag limits, seasons, research, etc. game populations are quite stable and many have increased tremendously. Their support comes from over $250,000,000 from hunting licenses and $100,000,000 from excise tax on hunting equipment sales each year.

The reason many people feel hunting today is a major factor in animal extinction, stems from several factors:

1. Hunting, in many areas of the world such as Asia, Africa, and South America has, today, become a major problem. This is due to inadequate laws governing sport hunting and poor ability to control market hunting and poaching. For example, between 1970 and 1980 Kenya's elephant population was halved....to 65,000. The price of ivory increased ten times during the period.

2. People today often become concerned over statistics stating that certain legally hunted species of animals are "endangered". In looking further however, one finds that only certain subspecies of these animals are truly in short supply. Examples are: Sonora pronghorn antelope, Columbian white-tailed deer, Mexican grizzly, Florida cougar, and Northern kit fox. These subspecies differ somewhat in appearance and almost always occur in habitats isolated from the commonly hunted species with a similar name.

3. Mainly, we all remember our history of dramatic wildlife losses during the 1800's. Elimination of habitat, coupled with hunting and trapping with virtually no game laws, took its toll.

A short list of examples:

The Passenger Pigeon

.....once one of the most abundant birds in America (possibly five billion);

.....during the early 1800's one naturalist estimated a flock in Kentucky contained over 2 billion birds, stretching 240 miles by 1 mile, containing 3 birds per square yard area;

.....one flight in New York took 14 hours to pass overhead;

.....in 1851, seventy-five tons of pigeon, salted or smoked in barrels, were shipped to New York food markets over just one railroad;

.....they were used for food (squab sold for 70¢ a dozen in cities), soap stock, hog feed, and feathers (144 dozen made a down bed);

.....14,000 birds were killed in one trap shoot in Peoria, Illinois, the forerunner of clay "pigeon" trap shoots of today;

.....netting, with the help of stool pigeons (live decoys), shooting (120 per charge of a blunderbuss), capturing the young (squabs) along with destruction of the old-growth oak and beech habitat' during 1850-1880 helped account for the demise of the species;

.....on September 1, 1914 the last passenger pigeon died.

The American Bison

.....the range was almost coast to coast from Canada to Mexico;

.....the population was 60-100 million;

.....by 1870 demand for hides was at its peak; meat was never the priority target;

.....in 1872-73 railroads from Kansas alone hauled 1,250,000 hides to eastern tanneries; 12 good hides being worth $98.00;

.....the United States government also sponsored the extermination to help subdue the Plains Indian tribes;

.....the all time low number in population was 541 animals by 1900.

Beaver

.....nearly eliminated from east coast streams from Maine to South Carolina by 1650;

.....by 1840 many western streams were depleted.

Sea Otter

.....hunted along the Oregon coast to near extinction until 1876;

.....was once abundant from southern California to Alaska;

.....population now approximately 50,000 due to reintroductions and rigid management.

Pronghorn (Antelope)

.....60,000,000 in early 1800, nearly as many as bison;

.....1850-1880 they were hunted commercially to scarcity;

.....killed for meat, hides, and to aleviate competition to cattle;

.....by 1908 20,000 existed; by 1920 less than 13,000 survived;

.....present day there are 500,000 animals and legal hunting.

Eastern Elk

.....virtually eliminated by 1870 throughout the eastern habitat.

Wolf

.....foe to livestock; shot and trapped nearly to extinction

Waterfowl Market Hunting - 1870-1900

.....tons of ducks and geese, sandhill and whooping cranes, rails, plovers, egrets, and snipes were sold profitably for meat, or feathers. During this time restrictions or controls were practically unknown so the market hunter took all he could, as often as he could. During these years this was true not only of market hunting, but most businesses dealing with our natural resources.

Sport Hunting

.....without game bag laws, sport hunting was carried to extremes! Sir St. George, a nobleman of Ireland, was guided up the Missouri River in 1855 by Jim Bridger; he was accompanied by 40 servants, 112 horses and 40 hounds; returned in 1857 having shot 2,000 bison, 1,600 deer and elk, and over 100 bear!

Subsistance Hunting

.....during the 1800's food hunting took its toll. For example, the record of game killed on the 16-month Lewis and Clark Expedition included 1,000 deer, 375 elk, 227 bison, 62 pronghorns, 35 bighorn sheep, 66 bears, and 250 birds...also 190 dogs were purchased from the Indians and consumed!

ANOTHER REASON FOR POPULATION PROBLEMS

Many Species Of Animals Survive By Producing A Large Number Of "Replacement" Young

	Gestation Period (Days)	Litters Per Year	Number In Litter	Maximum Age
Mouse	21	4-6	4-8	4
Rabbit	30	3-4	4-10	5-6
Opossum	13	1-2	9-16	4

Many Other Animal's Survival Is Not Based On Large Replacement Numbers

	Gestation Period (Days)	Births Per Year	Number In Litter	Maximum Age
Blue Whale	330	1 Every Other Year	1	30
African Elephant	640	1 Every Other Year	1	70
Rhinoceros	560	1 Every Other Year	1	40
Tiger	106	1 Every Other Year	1	25

DISCUSSION TOPICS AND QUESTIONS

1. Why is the state not overrun by mice and rabbits?

   Note: Being low on the energy pyramid, many are eaten by predators. The principal reason though, lies in "territorialism". As a habitat fills up, animals fight harder and create more stress in protecting their territory. Food decreases, disease increases, and reproduction reduces dramatically. "Nature" eventually controls all population explosions.

2. One pair of mallards may begin having young at one year of age and may hatch eight ducklings each year for ten years. After this time, if we count all the ducks produced by the original pair plus the breeding of the offspring, we could count 19,531,250 ducks! Why does this population increase not happen?

   Note: Weather conditions, disease, predators, food and hunters keep the population stable....so after 10 years two ducks would remain from the original pair.

Discussion Topics and Questions (Continued)

3. The larger animals listed above are endangered or threatened. How does the low birth rate contribute to this problem? How does long life help overcome low reproduction rate?

4. What are some "popular" examples of animals on the endangered species list?

   Note: Bald eagle, peregrine falcon, California condor, blue whale, blackfooted ferret.

5. Why are they endangered?

   Note: Loss of habitat, lack of ability to adapt, pollution.

6. What is being done to aid their survival?

   Note: 1) The Endangered Species Act of 1973 is one our strongest environmental laws. Habitat cannot be changed that would affect an endangered species.

   2) Stricter laws are needed outside the United States.

7. Why should we be concerned with animal extinctions?

   Note: Millions of animals have become extinct before man, but the rate of extinction has recently increased dramatically. In the future a new definition of our property rights may evolve. As landowners we have become accustomed to laws protecting hunted game that may live on our property. Now it appears that the rights of the landowner may be restricted further in order to save endangered species and their habitat.

8. Is hunting a cause of endangered species?

   Note: Legal hunting in this country is not a source of trouble. However, in many countries loose game laws, illegal poaching, and market hunting is an extreme problem. For example, between 1970 and 1980 Kenya's elephant population was halved... to 65,000. The price of ivory increased ten times during this time period.

   By observing animals around your home, which animals would have characteristics that would favor extinction? Now consider other animals in other environments.

   Consider requirements for food, water, shelter, abilities to adapt to changes; predators and other reasons for population loss; number of young born and frequency of births.

ANIMAL INTRODUCTIONS TO OREGON....POSITIVE ASPECTS

Wildlife introductions in Oregon include both exotic and native animals. The following game animals were "legal" introductions. Most are now legally hunted or caught.

Mountain Sheep

.....Lived in Oregon until 1900; brought in from British Columbia in 1954 to Hart Mountain. Later introductions included Leslie Gulch, Steens, Lostene area.

Mountain Goats

.....Released in 1950 at head of Wallowa Lake. Later releases include Sacajawea Park, Hurricane Creek, Matterhorn Peak and Tanner Butte near Mt. Hood.

Wild Turkey

.....First released in southwest Oregon...1926-1933. Other releases in Grant, Wasco, Klamath, Umatilla, and Lake County have established viable populations. Oregon is one of the 40 states that now has turkey populations.

Chukar Partridge

.....First brought to United States from Asia in 1893. Introduced in Oregon in 1951. Today's population is very successful.

Fisher

.....Last open season (trapping) was 1936. Only 8 trapped per year between 1924 and 1936. In 1949 was the last reliable sighting of Fisher in the Cascade Range. Was transplanted north of Klamath Falls in 1961 totally protected.

Ptarmigan

.....Introduced from Canada to high area of Wallowas totally protected.

Sea Otter

.....Trapped to near extinction along coast until 1876. 1970, 1971, etc. releases are being made totally protected.

Ring-Necked Pheasant

.....Most successful introduction in United States. First released in Oregon in 1882. 7.5 million harvested in South Dakota in 1945.

Bob-white Quail

.....Brought from southern United States in 1882.

Hungarian Partridge

.....Released in 1900 in western Oregon. Released in 1913 in eastern Oregon.

German Brown Trout

.....Introduced into Deschutes River system and several large central lakes.

Atlantic Salmon

.....Imported from Quebec to Hosner Lake.

Lake Trout

.....Introduced to Odell Lake from eastern United States.

Striped Bass

.....Spreading from San Francisco (first introduced in 1879).

Shad

.....Introduced approximately 100 years ago to California....has spread to the Columbia River.

Grayling

.....Imported from Montana.

Brook Trout

.....Imported from New England.

Others?

.....Also Oregon introductions: bass, crappie, bluegill, yellow perch, bullhead, and channel catfish.

ANIMAL INTRODUCTIONS TO OREGON....NEGATIVE ASPECTS

Nutria

.....Furbearer from Argentina; although advertised as a "get rich quick" animal, the fur turned out to be worthless; population now increasing through wetlands of at least eighteen states; very destructive to agriculture, dikes, and levees.

House Mouse and Norway Rat

.....Entered the country as stowaway on ships.

Bull Frog

.....From Missouri and Louisiana; predator on native frogs, etc.

Carp

.....One of the most disastrous introductions; came to Oregon in 1880; introduced from Germany as a food fish to 25 states in 1879. Congress appropriated money for its shipment to any state that wanted them. By 1883 more than 500,000 had been shipped. By voraciously devouring rooted aquatic plants, carp cause muddy water and thereby desimate fish and waterfowl habitat.

House (English) Sparrow

.....Introduced after 1850 mostly by bird enthusiasts in New York. Locally it was introduced by the Portland Song Bird Club. It was originally thought that the birds might control insects, however it was later found that only 2% of the bird's diet included insects. In the 1800's tens of thousands were shipped to midwestern shooting clubs, currently causing heavy damage to grain and fruit crops.

European Starling

.....Introduced successfully in 1890 by Eugene Scheifflin who wanted to introduce every bird to America that was mentioned in Shakespeare's writings. It was the bird-minded Scheifflin family that was partly responsible for the introduction of the house sparrow 25 years earlier. Damage to fruit crops, fouling of cities and displacement of native birds rapidly increased.

Opossum

.....Entered Oregon during the 1930's; probably by the Civilian Conservation Corps; source was southeastern United States; population is expanding rapidly (10,000,000 in Oregon). Their diet includes living and dead matter, which is having a devastating impact on bird and other animal populations.

Common Street Pigeons

.....Native of Europe and Asia; domesticated over 5,000 years ago; possibly our first domesticated bird; first came to America by early settlers; known for their homing ability and food source; carrier of many human diseases, including parrot fever.

DISCUSSION TOPICS AND QUESTIONS - INTRODUCED SPECIES

1. What are some examples of introduced animals at the Outdoor School?

   Note: Opossum, ring-necked pheasant, leopard slug, house sparrow.

2. Why are animals introduced into a new area?

   Note: Many animals are introduced for the purpose of hunting. Most of these being herbivores or insectivores; find a niche in the food web.

   Many animals are considered useful as food or fur source. Many are introduced first as pets being then released to the wild. Many are accidentally brought into the state.

3. Who is legally authorized to make animal introductions?

   Note: Only Federal and State Wildlife agencies.

4. From the many introduced animals in the state, what can you tell about the climate, geography, and other aspects of the animal's native environment?

   Note: Street pigeon's native habitat include cavities in rock similar to those found in buildings.

   Chukar partridge's dry-land, Asisan habitat is very similar to the river breaks of eastern Oregon.

   German brown trout is best suited to warmer water which helps one imagine the conditions of many European streams.

5. Often dogs and cats are wrongfully released into the wild. Many times these "feral" animals survive for many years. What is wrong with this?

   Note: These and other less common pets are predators on wildlife. Cats are especially harmful on bird populations. Dogs, occasionally working in packs and often cross-breeding with coyotes (coy dogs) can become serious problems to deer, domestic animals and people.

6. Why should residents of western Oregon be especially concerned with the importation and release of exotic species?

   Note: Western Oregon, like many other mild climate areas, has an agreeable habitat for many imported "pets" and plants. For example, the number of fish (mostly warm water) imported into the country is well over 100,000,000 annually. Although the intention is for these fish to be contained, a suitable habitat is sometimes found in many mild-weather states. Florida now is the home of twenty-three exotic birds. Hawaii is burdened by forty-six exotic birds. Most of these animals compete for available food and cover with native animals.

CONCEPT

An energy pyramid is a flow of energy from the sun through plants to successively less numerous organisms.

The energy cycle involves producers, consumers, and decomposers.

AT OUTDOOR SCHOOL

Discussion about animals at Outdoor School should bring your students to the conclusion that all animals are involved in a variety of chains, webs, cycles, and pyramids. To understand the basic principles of ecology one must appreciate how animals "fit in" to these relationships. In a habitat, each animal occupies a niche and has a certain role in its own environment. Students trying to find each animal's niche, have to investigate the animal's activities, particularly its food (energy) source. Knowing what it eats and what may prey on the animal will help students visualize it in a food chain. Since no animal eats only one kind of animal or plant or is prey for only one species of predator, it is more realistic to imagine the animal in a food web.

Students should understand that the foundation of this food web is green plants. Energy from the sun is used by green plants and then transferred to herbivores and then to carnivores. By examining each animal's diet, your students can divide the world (ecosystem) conveniently into four parts: 1) non-living, 2) producers...mainly green plants, 3) consumers....animals that eat animals and plant matter, 4) decomposers....animals and plants that break down dead organisms and release substances useful again to the producers. Students can see that the energy cycle is one key in understanding the interrelationships between plants and animals.

At Outdoor School, your students may have found animals, such as the red-tailed hawk, that are "on top" of the food pyramid. When looking at all animals or plants involved in the hawk's food chain, we can arrange them in a pyramid of numbers. At the bottom are the hundreds of different plants; the next layer involves a fewer number of herbivores. At the top of the pyramid is the single hawk (or any of a small number of carnivores). Your students, imagining plants and animals in a pyramid, will better understand how energy is transferred and why animals on top have a more precarious existence. They can see this being due to their relatively few numbers and their dependence on the interactions of many animals and plants "below" them.

AFTER OUTDOOR SCHOOL

Reviewing this concept in the home school environment, students can see that not only wild animals, but domestic animals and human beings fit into the same food webs, food pyramids, and the energy cycle.

The key element or cause of these interrelationships is, of course, food. We, along with all other animals, can never be independent of the natural system because of this need. Like the hawk we are on top of the food pyramid. Additionally, our high standard of living, as well as what we eat have repercussions throughout the natural world. Students exploring additional interrelations can later develop "the basics" for a better understanding of endangered species, game management, and man's massive impact on the environment.

CONCEPT

The amount of food, water, and shelter are the major factors which determine the size of an animal population.

Competition must exist between animals of the same species to ensure the health of the species.

AT OUTDOOR SCHOOL

Your students may be disappointed to find that few deer live in the Outdoor School area. If there seems to be food in abundance, they can easily come to the incorrect conclusion that there are "too many people" or "too much hunting". One of the purposes of Outdoor School is to learn that the land or habitat has a carrying capacity or, an ability to support only a limited population of each animal species. Food may appear to be abundant during the Outdoor School session, but during the winter may be reduced to the point of being the factor that limits the population. If food is not in short supply, something else such as weather, available shelter, or water (too much or too little) may be the limiting factor in the area.

Since the carrying capacity of the land is limited, animals compete for use of the land and those resources which may be in short supply. The animals that are strongest and most able (with the best eyesight, speed, etc.) will survive the competition and reproduce young. This is a key "law" in both animal and plant success.

In many cases animals mark and defend territories as a means of ensuring adequate food or other necessities for themselves and their young. For example, in the spring at Outdoor School students will hear certain birds singing to establish nesting territories. Students learn that animal populations are kept within the carrying capacity of the land by competition for these limited necessities and by the establishment of territory.

AFTER OUTDOOR SCHOOL

Students should be able to imagine, if they were wildlife managers, how they might increase the population of an animal. One way to begin would be to eliminate or lesson limiting factors. However, as one factor is removed, another factor then becomes the crucial one. Your students might, for example, decide to increase the song bird population in the school yard by using bird feeders. This may eliminate the most crucial limiting factor, (food) but now the lack of nesting area or the next door cat could become the main limiting factor.

These "laws of nature" apply anywhere in the world and will help students to understand not only wildlife problems and their solutions, but will also help them gain an understanding about our own human population. Appropriate follow-up could explore our own need for territories, our limiting factors and the land's ability to support man as well as wildlife.

LINKING THE OUTDOOR SCHOOL WITH THE HOME ENVIRONMENT

GOALS

Students should be learning:

That our human population is affected by the same factors that influence wildlife populations.

For example:

The carrying capacity of land is a controlling factor in human populations as well as other animal populations.

That we, as humans, are also part of the food web and energy pyramid.

In the producer-consumer-decomposer cycle, humans (as consumers) must always rely on the natural system as a producer of our food (and other energy) and as a decomposer of our waste.

KEY WORDS

Food Chain
Food Web
Energy Pyramid
Carrying Capacity
Producer
Consumer
Decomposer
Territory

MULTNOMAH COUNTY E.S.D. FILM LIST

Animal Migration - #82953
Birds In Your Backyard - #40817
Conserving Our Wildlife - #40980
Populations - #81676
Wildlife Balance In Nature - #42149
Animals And Their Food - Rev. #42292
Animal Predators And The Balance Of Nature - #41548
Balance In Nature - #80461
Birds Of Prey - #40053
Food Cycle And Food Chains - #40274

CARRYING CAPACITY AND THE ENERGY PYRAMID AT HOME

Every animal found at the Outdoor School is involved in energy pyramids and a food web. In many occasions the major influence on the size of wildlife populations is the amount of food. Understanding how the land's production of food influences wildlife populations can serve as a foundation for understanding how the land also influences the human population.

Wildlife, observed during Outdoor School, secures enough food by travel and establishment of territory. We often forget that our own territory must include acreage for the production of our food. In 1910, each person required approximately 2¼ acres of land to produce enough food for one year.

Today, excluding seafood*, each of us requires approximately one acre of food "territory". There are about two acres of crop land available per person in the United States. This excludes range and pastures.

* 1/5 of our protein currently comes from fisheries.

BACKGROUND INFORMATION

By comparison, an area nine times the area within the city of Portland or twice the area of Multnomah County, is needed to supply food for the 562,640 residents of Multnomah County.

Flour

How much land is needed to supply flour to Multnomah County?

Annual per capita consumption is 116 lbs.

116 lbs. of flour = 162 lbs. of wheat.

2,820 lbs. of wheat = average harvest per Oregon acre (41 bushels/acre; 60 lbs./bushel)

Therefore, each person needs = .06 acre for wheat production every year.

There are 43,560 sq. ft./acre.

Therefore, an area approximately 50' x 50' for wheat production is required per person.

Multnomah County residents need 33,758 acres of wheat "territory".

Oregon grows 1,245,000 acres of wheat.

Sugar

How much land is needed?

Per capita consumption is 91.3 lbs.

91.3 lbs. = 702 lbs. of sugar beets.

56,000 lbs. = average harvest per Oregon acre.

Therefore, each person needs = .013 acres of territory for sugar each year.

= an area approximately 24' x 24'

Multnomah County residents need 7,314 acres of sugar territory (excludes the fact that sugar also comes from sugar cane).

Oregon produces 11,300 acres of sugar beets annually.

Fruit

How much land is needed?

Per capita consumption is 86.5 lbs. per year. (To simplify, apples are used for example only.)

2,000 lbs. average apple harvest per acre.

Each person (assuming the only fruit eaten were apples) needs

$\frac{86.5}{2000}$ or .04 acres of fruit

Oregon produces 340,000 tons of fruit and nuts annually.

Beef

How much land is needed?

Per capita consumption is 107 lbs.

Consumption of one steer (2-year-old/500 lbs.) = 7,300 lbs. of hay.

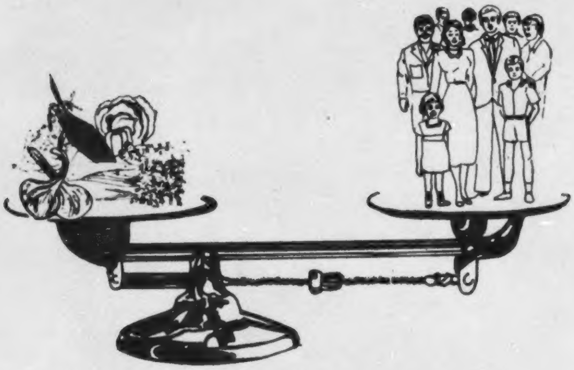
Each steer requires - approximately two acres of hay and 1/30 acre of grain (e.g. corn).

Therefore, each person needs approximately ¼ - ½ acre of beef "territory".

Multnomah County residents need 140,000 - 280,000 acres for beef production.

The amount of beef consumed in the county is approximately 150,000 cattle annually. The slaughter of cattle throughout the entire state in 1979 (130,000) could not supply just Multnomah County.

A SHORT LIST OF FOODS NEEDED TO SUPPORT MULTNOMAH COUNTY

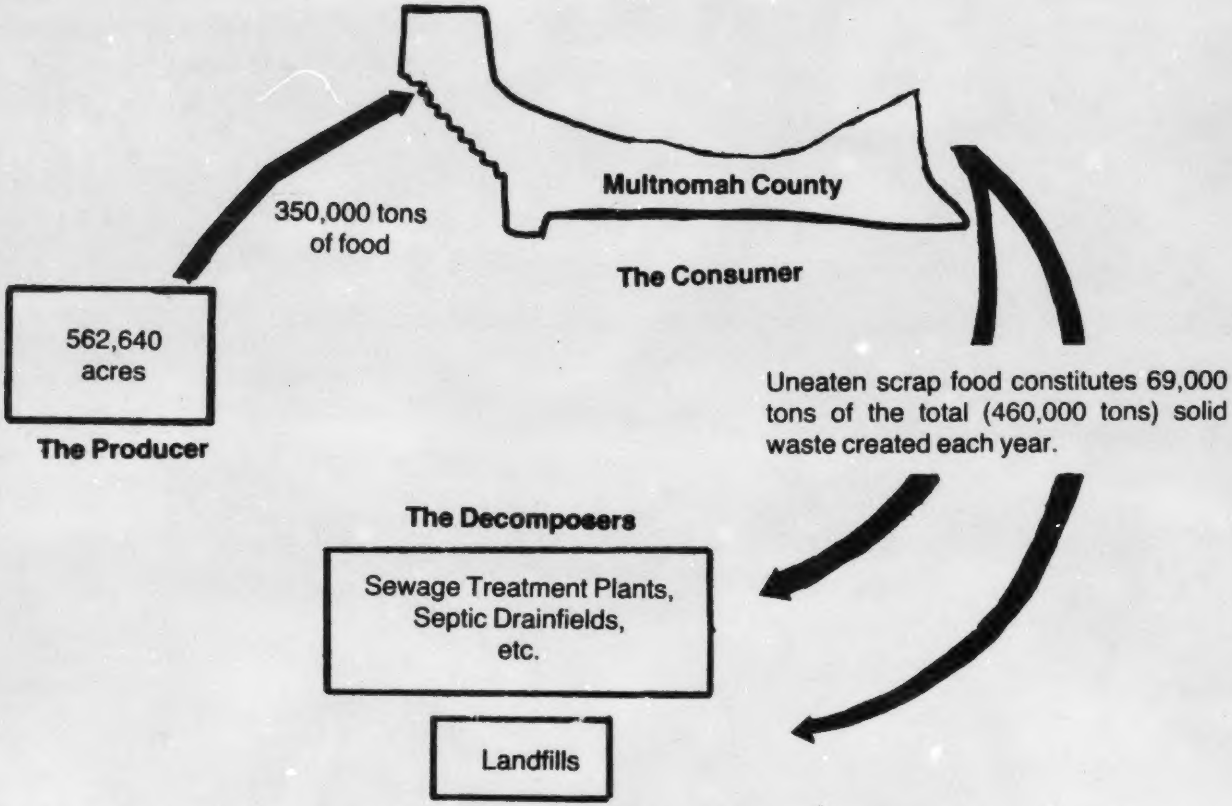


The list below represents about one-half the 350,000 tons of food needed annually. The other one-half includes a multitude of less major food items.

To Supply Multnomah County		Per Capita Consumption
Beef	60,540,064 lbs. per year	107 lbs. per year
Pork	39,497,328 lbs. per year	70 lbs. per year
Fruit	48,668,360 lbs. per year	86.5 lbs. per year
Flour	65,266,240 lbs. per year	116 lbs. per year
Rice	11,196,536 lbs. per year	19.9 lbs. per year
Sugar	51,369,032 lbs. per year	91.3 lbs. per year
Vegetables	131,095,120 lbs. per year	233 lbs. per year
Milk, Cream	133,345,680 lbs. per year	237 lbs. per year
Ice Cream	9,902,464 lbs. per year	17.6 lbs. per year

PRODUCERS, CONSUMERS, AND DECOMPOSERS AT HOME

Considering that each family of four uses 2½ tons of food each year:


Multnomah County
350,000 tons of food
The Consumer
562,640 acres
The Producer
Uneaten scrap food constitutes 69,000 tons of the total (460,000 tons) solid waste created each year.
The Decomposers
Sewage Treatment Plants, Septic Drainfields, etc.
Landfills

In the Outdoor School setting, wildlife acting as consumers do not create a solid waste problem. All animal waste is biodegradable and returns nutrients directly to the soil, which will be part of future food production. These nutrients are returned, making a stable, closed system relatively close to the animal's food supply.

Similar to wildlife, in our urban setting, we rely on the natural system not only for a producer of our food, but as decomposer of our waste. Each year the people of Multnomah County create 460,000 tons of solid waste. 15% of this, or 69,000 tons, is unconsumed food scraps. Most of the consumed food, of course, becomes part of the 80,000,000 gallons of fluid sewage treated daily from Portland.

Unlike the localized, natural system described above, our human food source "territory" is much larger and more diverse. Contrarily our waste is all deposited close to home. The nutrients taken from our huge food source "territory" cannot be supplied by our own human wastes, and must be supplied in other artificial ways....or be lost to our "territory" and thereby reduce its carrying capacity.

DISCUSSION TOPICS AND QUESTIONS

1. Compare wildlife in the natural world to our own urban population in regard to carrying capacity of the land....wildlife vs. human territories.

   Note: During the comparison, the reasons should become obvious why an understanding of wildlife in the natural world can be a foundation for understanding our urban situation. For example, within a short walking distance in a wildlife habitat, one will find evidence of closed loop nutrient cycles and populations which are generally self sustaining. We can then compare our own lives to this standard and may find that departure from a self-sustaining life style eventually creates a series of problems.

2. Although the carrying capacity of the land in regard to feeding people has generally increased in the United States, many countries have a low or decreasing carrying capacity. What are some reasons for this?

   Note: Fertilizers, herbicides, insecticides, irrigation, better machinery, and better land managing techniques have all aided in increased production of the land. Many factors such as increased costs, supply of fossil fuels, etc. are limits of this growth. Past increases in world-wide food production have now leveled off.

3. There are many countries where the human population exceeds the carrying capacity of the land. What happens during this situation? Has the carrying capacity of the land been reached on a world-wide scale?

   Note: Starvation (1/6 - 1/10 human annual mortality) is generally the last phase of a series of problems. Poor life style/nutrition and dependence on other countries are also common problems.

4. Only a few of the acres that might be considered needed territory for the production of food for Multnomah County's people lie within this county. Most of the other acres are scattered throughout the United States and the world. What food would come from Multnomah County, Oregon, other states, other countries?

   Note: The 320 acres of strawberries in Multnomah County have an average production of 7,300 pounds per acre.

5. In the United States approximately 2,000,000 acres of farm land (approximately the size of Multnomah, Clackamas, and Washington Counties) is turned over to non-agricultural use every year. What are examples of this locally?

   Note: In the last 75 years over 2.5 billion acres in the United States have been covered over by roads, cities, parking lots, airports, etc.

CONCEPT

Major factors affecting soil include climate, topography, plants, animals, parent material and time.

AT OUTDOOR SCHOOL

Students realize that there is a great variety of soil types, each with a different potential. Students can best understand the proper uses of the soil if they understand the major factors that caused the development of these many types. Looking at the soil profile, your students will see rock or parent material at the lowest layer. The kind of rock and the amount of weathering it receives, has a major effect on the type and quantity of soil developed. For example, the alluvial soil along the Sandy River at Collins is from a river deposited mudstone parent material, while the parent material at the Howard Outdoor School site is of volcanic origin.

The climate (especially rainfall and temperature) greatly affects soil development. Rainfall causes erosion, leaches nutrients from the soil, affects pH, and makes dissolved nutrients available to plants. Temperature affects weathering and biological processes including seed germination. In turn, the plants which act as insulators from weather, affect the soil temperature and moisture.

Your students measure slope with a 50" board, a level, and a yardstick. They discover that various slopes affect the rate of water runoff and erosion. The degree and direction of slope also affect temperature which in turn influences evaporation and plant growth. Slope, therefore, is a major factor when considering plant growth and proper land use.

Students also observe mounds of fresh soil, tunnels, chewed leaves, and partly eaten sticks. This evidence of burrowing animal activity, along with the results of microscopic life, are understood to be vital to soil and the natural world. The aerating and cultivating effects of moles, gophers, worms, and mountain beaver, etc. are also studied. Breaking-down of dead animal matter into available nurtrients for plants must also be considered an essential function of animals. From these observations, the effect of soil animals as nutrient recyclers and soil developers can be better understood.

Since students spend only one day on soil study it is difficult to get an understanding that millions of years of interaction of plants, animals, climate, slope, etc. are needed to form soil. The understanding of this element of time is vital to realizing the consequences of soil misuse. That which took so long to form......can be so quickly destroyed.

AFTER OUTDOOR SCHOOL

At Outdoor School students learned the factors that affect soil in a natural area include parent material, climate, topography, plants, animals, and time. In an urban environment man has an equally dramatic influence on the soil.

By looking around the neighborhood, your students can find ways that man has directly or indirectly changed the natural soil profile. Can they find places where weathering has been slowed down or speeded up due to something man has done? Usually the vegetation in disturbed areas is different from that found in the natural environment. Has construction had an effect on the soil? What happens when the ground is paved over, built upon, or frequently walked over? What things about the soil can we change? What can we not change? These investigations will help students reach the goal of understanding both natural and man-caused impacts on the soil.

CONCEPT

Composition of soil affects plant growth, water content, and ultimately animal life. Soil composition changes with depth.

AT OUTDOOR SCHOOL

From the observation of the soil profile and making micro-monolith cards, your students can see at least three distinct layers of soil. They learn that the relative age of soil can be judged by this observation....the older soils, subject to more weathering and leaching, show more distinct layering. Flooding, gravity, and alluvial action of past glaciers (Collins and Arrah Wanna) also play a part in this layering process. Students, using gold pans, can be shown this action on a minature scale. Panning soil with water is used to demonstrate how soil particles of different densities settle into distinct layers due to water and gravity. Various colors, which can be an indicator of soil fertility, are also observed. From the dark top layers to the lighter sub-layers, they can see that color depends on the type of rock from which the soil is formed and also the amount of surface organic material that has been added over the years.

Your students see how weathered rock along with living and dead animal and plant material go into making the thin layer of "top soil" that supports all life. Water and air are also part of this fertile layer and too much or too little of either of these elements can destroy the soils ability to support life. It is understood that most Outdoor School soils have a defined soil structure, with "space" for this air and water movement. However, this structure has a fragile nature. Students see soil compaction on trails.... an example of reduced air retention and water percolation. This destroyed soil structure is compared to a soil structure in an undisturbed envrionment.

The soil texture (particle size) varies from site to site. Collins, having a high sand content, differs greatly from the other sites which have soils with a high clay content....from the volcanic parent material. Students use percolation tests to see the differences in water absorption between different soil types. Clay "absorbs" water slowly and then holds water so tightly that some may not be available to plants. By studying various soil textures which might be described as gritty, smooth, sticky, etc. your students can see the advantage of a mixture (loam) which includes sand, silt, and clay.

AFTER OUTDOOR SCHOOL

Geologic history, soil productivity and land use can all be better understood by studying the soil profile. These profiles are often very definitive and can be readily seen in highway cuts and building construction sites.

Understanding soil composition will help answer two questions: Is it fertile? Is it stable? Nearly every school yard in our area is comprised of high clay content soil. Left undisturbed, it can be productive, but compaction or tilling in wet conditions destroys the structure. The possibilities are endless for on-going plant growth experiments using a variety of soil mixtures. Potted plants can be used inside and test plots used outside to observe differences in plant growth using a sand, clay, silt, or mixtures of the three types. The main goal of this lesson may not be to develop your students gardening or farming abilities, but to lay a foundation for later understanding of how every country's culture and prosperity is directly tied to the productivity of its soil.

CONCEPT

Man has both a positive and negative effect on erosion.

AT OUTDOOR SCHOOL

Erosion is studied because of its tremendous destruction to the soil, worldwide. The United States Soil Conservation Service estimates that 180 million acres of our country has been damaged by water and wind erosion. This loss, at a rate of one billion dollars worth of topsoil annually, has resulted in the loss of approximately one-third of our nation's topsoil since colonial times.

Students at Outdoor School determine the kinds of erosion that are taking place around them. Sheet, rill, gully, bank, and splash erosion are generally seen at the site. Students begin to understand the causes of this erosion and can perceive the methods to control it.

Students also learn that soil eroding into streams by direct runoff increases turbidity and brings pollutants from the land to the streams. They also see how erosion affects plant growth and animal life. Visible examples also show how slope, soil structure, and improper land use can affect erosion.

AFTER OUTDOOR SCHOOL

During review, the point should be made that erosion by wind and water is a natural process and has played an important part in creating many land forms. (The Grand Canyon, for example, was carved out by the Colorado River.....a clear example of water erosion.) Man by his actions, however, can slow down or accelerate the speed of erosion.

People do not have to be farmers or land owners to produce an effect on erosion. Where one chooses to walk, play, ride a bike, drive a car, or build a house is a decision that can influence the speed of erosion. In urban areas students may easily observe all levels of erosion, including extreme cases of gully erosion where new construction of roads and buildings is taking place. Loss of ½ inch of soil over an acre means the loss of over 900 cubic feet per acre.

Students should find out what is (or isn't) being done to improve these situations, and whether poor planning or site selection helped cause the situation. Would better knowledge of soil have been beneficial? Where did the eroded soil go? (Where did the water go?) Can the volume of soil loss be measured?

Most of the erosion of our region is caused by water. However, in some agricultural areas and new housing projects in east Multnomah County one can find good examples of wind erosion from the strong east winds that occasionally blow down the Columbia Gorge.

LINKING OUTDOOR SCHOOL WITH THE HOME ENVIRONMENT

GOALS

Students should be learning that:

> Urban soils, like Outdoor School soils, have varying capabilities because of slope, fertility, water intake, stability, etc.
>
> High quality Class I soils, common in the Portland area, are being rapidly covered by buildings and roads.
>
> We are all tied to land use problems due to our daily dependence on soil as a provider of our food and foundation of our roads and buildings.
>
> Erosion, observable at Outdoor School is a major soil problem in urban areas.

KEY WORDS

Fertility

Erosion

Texture

Structure

Slope

Land Classification

MULTNOMAH COUNTY E.S.D. SOIL FILMS

Life In A Cubic Foot Of Soil - #41095

Living Soil - #80107

Understanding Our Earth: Rocks And Minerals - Rev. #82885

Understanding Our Earth: Soil - Rev. #82886

World At Your Feet - Soil - #80044

Erosion - #40472

Erosion Leveling The Land - #80291

Soil - Problems Of Conservation - #80600

Soil - What It Is And What It Does - #40209

Soil Makers - #82078

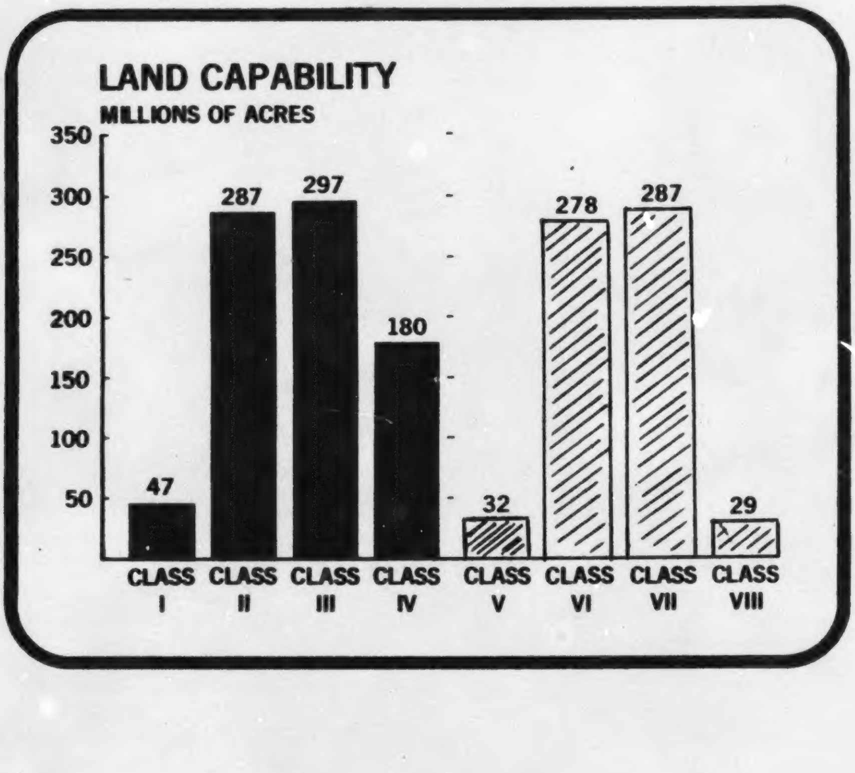
BACKGROUND INFORMATION

On the average, four square miles of United States farm land are being paved over each day. This amounts to 1,000,000 acres per year. This land is equal to a strip of land ½ mile wide running from New York to California. Locally, over 600 acres per year are being removed from agriculture and rural use.

Wind and water erosion accounts for an additional loss of 4,000,000 acres each year.

Since the nation has 2.3 billion acres of land (and water), the small fraction of land being lost each year may seem like a distant problem. Suburbs, highways, airports, shopping centers, etc. still occupy only a small percent of our total land surface. The problem is that much of the land lost from production is Class I soil. As indicated by the graph below, this top rated fertile soil is in short supply.

In these eight soil classes exist over 100,000 different kinds of soil. One county may have as many as one hundred different kinds of soil because of different parent material, climate, topography, etc.



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LAND-CAPABILITY CLASSES

Soils suited for regular cultivation are in classes I, II, and III. These soils can also be used safely for pasture, range, woodland, or wildlife.

Class I

Class I contains the soils that are nearly ideal for some of the common field crops. They can be safely cultivated year after year without any special treatment to control runoff or conserve the soil. They are nearly level and the risk of erosion by either wind or water is low. They are deep, well drained, and easy to work. They hold water well and are either fairly well supplied with plant nutrients or they respond well to fertilizer.

Class II

Soils placed in class II have limitations that reduce the choice of plants or require some conservation practices. The limitations are few and the practices easy to apply, but the land user has less leeway in choice of plants or practices than with class I land. For example, among the practices that may be needed for cultivated class II land that is gently sloping and deep are contour tillage, stripcropping, stubble mulching, and cropping systems that include grass and legumes. Some class II land is nearly level and somewhat wet but can be drained easily.

Class III

Soils placed in class III have severe limitations that reduce the choice of plants or require special care to save soil and water, or both. The fewer number of practical alternatives and the extra effort needed to conserve soil and water distinguish class III land from class II.

Limitations of class III land restrict the amount of clean tillage; the timing of planting, tilling, or harvesting; the choice or yield of crops; or two or more of these. Most of the limitations....for example, gentle to strong slopes, somewhat sandy soil, shallow soil, too little or too much water..... were there before the land was used for crops. Some may be the result of erosion brought on by the way the land has been used.

Class IV

Soils placed in class IV have very severe limitations that make them marginal for common field crops, require extra care when cultivated, or both. The needed practices may not be as effective as they are for class II or III land. Most class IV land can, with proper safeguards, be used for pasture or range, wildlife food and cover, recreation, or woodland if the climate is favorable.

Some poorly drained, nearly level soils that are not subject to erosion but are poorly suited for some crops because of wetness, frequent overflows, or low yields are placed in class IV. Some class IV land is well suited for special crops such as rice, truck crops, fruits, nuts, or ornamental trees and shrubs.

Class V

Soils placed in class V have little or no erosion hazard but have other limitations that are difficult to remove by practical means. The limitations prevent tillage of crops with standard farm equipment. Class V land is restricted largely to pasture, range, woodland, wildlife food and cover, recreation, or watershed protection. Though the land is nearly level or gently sloping, it is wet, stony, or often overflowed by streams, or the growing season is too short for most crops.

Class VI

Soils placed in class VI have severe limitations that make them for the most part not suited for tillage and restrict their use largely to pasture, range, recreation, watershed protection, or wildlife food and cover. Some are well suited for woodland but some are not since the growth of trees depends on climate as well as soil.

Range or pasture improvements such as seeding, liming, fertilizing, and water control by means of contour furrows, drainage ditches, diversions, or water spreaders are practical.

Some class VI land can be used safely for the common crops if managed with extreme care. Some also can be used for long-term meadows and sodded orchards that do not require tillage or for special crops, such as blueberries, that grow in soils unlike those that are best for the common crops.

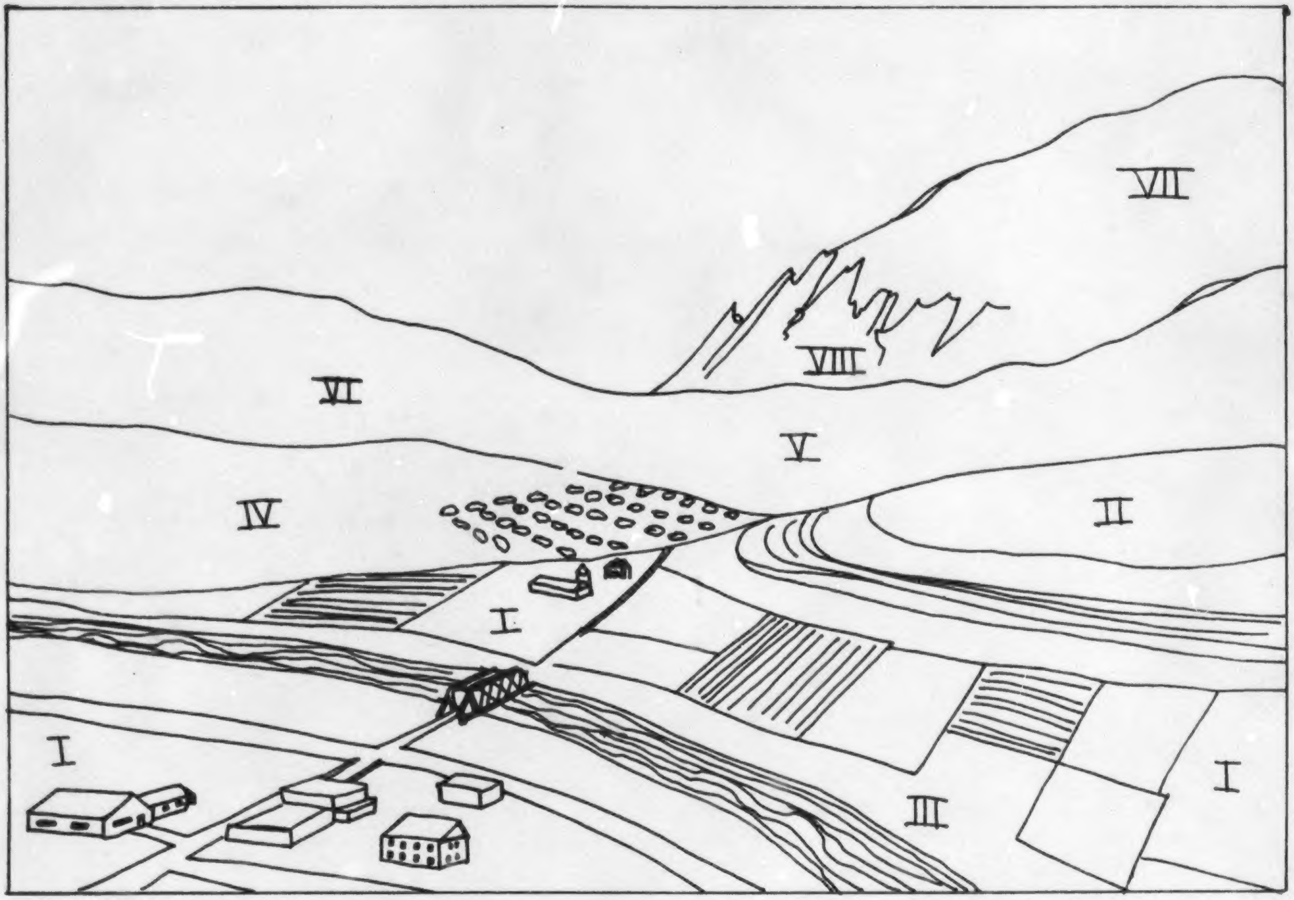
Class VII

Soils placed in class VII have one or more very severe limiting features that cannot be changed without major reclamation. The limiting features make them unsuited for common crops that need tillage and restrict their use largely to grazing, woodland, or wildlife food and cover. With specific management practices a few can be used for special crops....such as cranberries and certain ornamentals. Because of physical features of the soil, such pasture or range improvements as seeding and such water-control measures as contour furrows, ditches, diversions, and water spreaders are impractical to apply. This is a distinguishing difference between most class VI and class VII land. Some class VII land is well suited for woodland; some is not, mainly because of climate or the small amount of water held by the soil.

Class VIII

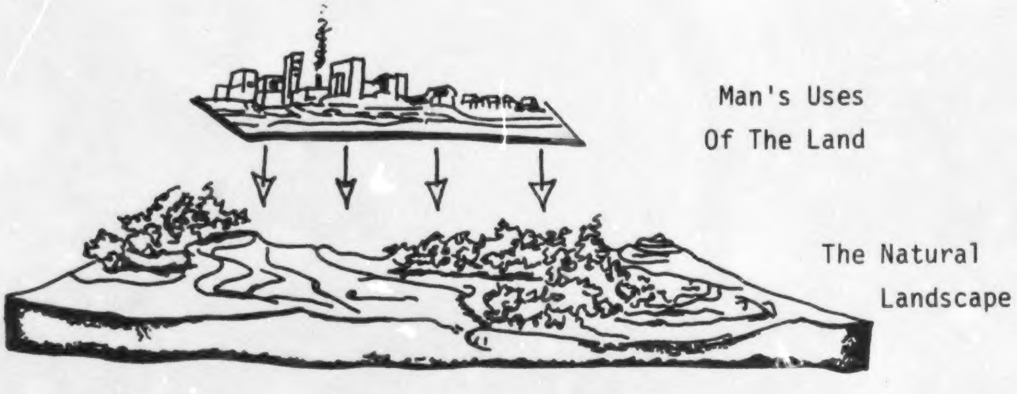
Soils and landforms placed in class VIII have limitations that preclude their use for plants grown to be harvested. With major work a few can be "reclaimed" for special use. Some have scenic value. Benefits from wildlife use, watershed protection, or recreation are possible.

Badlands, rock outcrops, sandy beaches, mine tailings, and other nearly barren land are in class VIII.


VII
VIII
VI
V
IV
II
I
I
III
I

What type of land is around (and under) your home and school? If Class I lands have been covered, less productive lands must produce our food. This increases erosion as well as water and energy consumption. Wildlife habitat is also lost. Our values, reflected in current land use laws, control how and where the city grows.

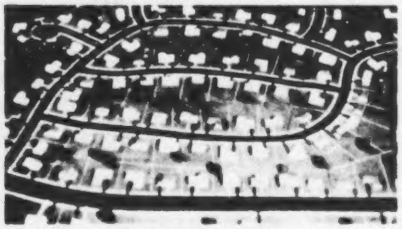
How do buildings around you affect the land?


Man's Uses
Of The Land
The Natural
Landscape

INCREASING OUR POPULATION DENSITY - ONE STEP TOWARD SOIL CONSERVATION

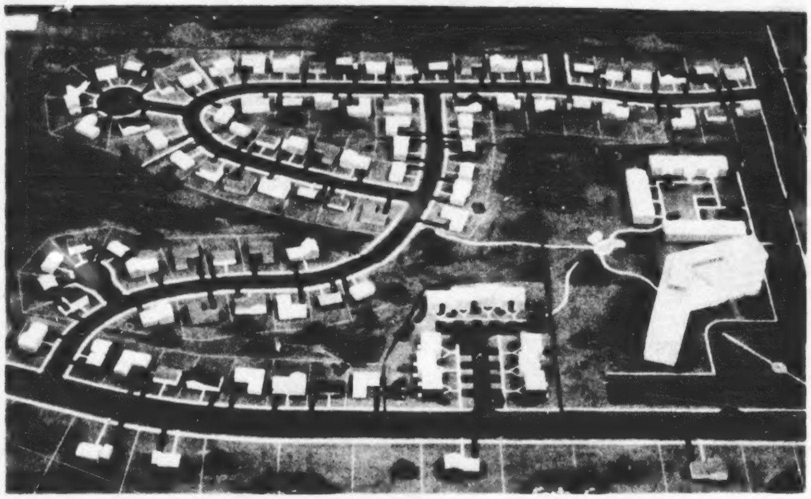
Most students can quickly list many disadvantages to living close together in a heavily populated neighborhood. However, when considering soil conservation, they may discover several overlooked advantages.

Consider the three 40-acre communities below:



PLAN I: 101 single-family homes

PLAN II: 125 single-family homes



PLAN III: 208 homes, town houses, garden and high-rise apartments

Plan I: Holds 101 families and includes 6.4 acres* of roads.

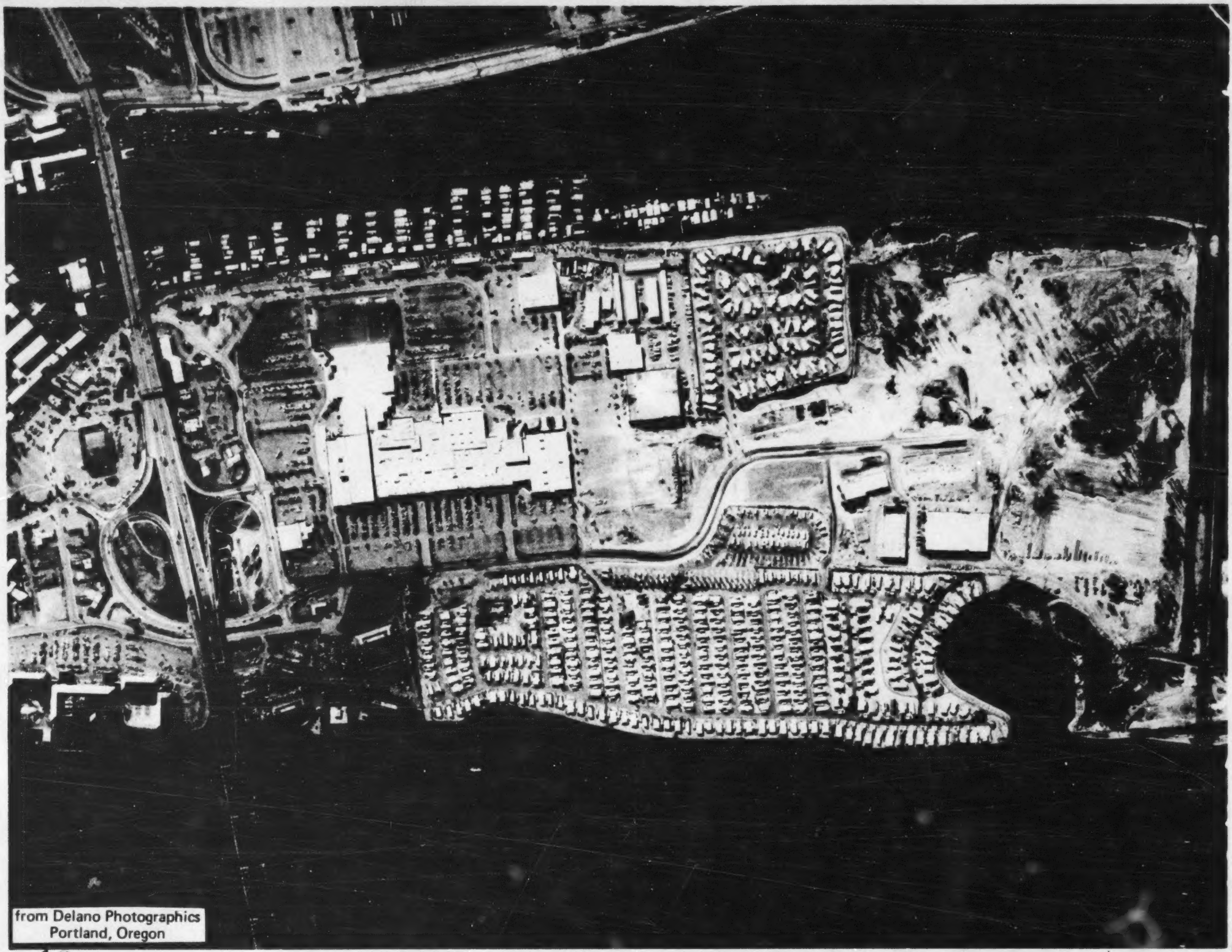
Plan II: Being better planned, holds 125 families and includes 5.6 acres of roads.

Plan III: Has room for 208 families and includes 5.3 acres of roads, and the most open land.

* During a 1" rainfall, 23,232 cubic feet of water will strike these roads and will never reach the soil.

Observations in your student's own community can help one see that:

1. High in-town population density means more surrounding "open land" (this open land is our natural resources bank).
2. Well planned, high density neighborhoods have more land available for recreation, gardens, trees, and crucial absorption of winter rainfall.



from Delano Photographics
Portland, Oregon

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HAYDEN ISLAND

Hayden Island is an example of varying land use and population density. With an "Outdoor School" knowledge of soil we can look at Hayden Island and observe how we are affecting the soil and how the soil, in turn, is affecting everything on it.

The mobile home park on the island is an excellent example of high density housing. Although privacy and large backyards are sacrificed, land in other parts of the island is still "in production".....supporting plants, wildlife, absorbing rainfall, etc. Other natural resources, such as high quality mason's sand (unlike beach sand, this sand is angular) also remains accessible.

House boats at the bottom of the picture are an example of alternative housing....using water instead of soil for a foundation. How does erosion and other soil problems affect them?

Jantzen Beach Shopping Center, and parking lot just west of the I-5 Freeway is an example of a large amount of land being sealed from taking in rainfall, producing plant life, etc. Because of the soil composition and topography in this specific area, top rated Class I soil was not lost by the building of these stores.

What kind of off road recreation is obvious in the picture? What impact does this have on the land? What are the alternatives?

Note: Motorcycle tracks in one corner of the picture.

The distance from the I-5 bridge to the railroad bridge is about one mile. Approximately how large is the Jantzen Beach Shopping Center?

Note: About ¼ mile (1,320 feet) on a side. This would be 1,742,400 square feet or about (1,742,400 divided by 43,560) 40 acres.

DISCUSSION TOPICS AND QUESTIONS

1. Our homes and buildings not only occupy some of our best soil, but also occupy some of our worst soil. Can you think of examples of homes built on flood plains or built too close to water? What are the problems with building in wet areas?

Note: It is estimated that 25,000,000 Americans live on flood plains and most do not even realize it. Flooded homes and streets are common in these areas. Poorly drained soils in these areas also cause major problems with the workings of septic systems.

Homes close to river banks and ocean shores are subject to eroding banks (e.g. during the Mt. St. Helens eruption, homes along the Toutle River were dramatic examples of this). Riprapping, or placing rock or concrete on stream banks or ocean shorelines is an expensive and sometimes only a temporary solution to this problem.

1a. What are problems with building on steep slopes?

Note: Erosion can be very detrimental. Buildings can drop and foundations can crack from being built on unstable soil. Steep slopes, behind buildings, common in Multnomah County direct surface run-off and soil water down to (and sometimes into) the buildings.

2. How does the loss of soil affect our food prices?

Note: Food prices will rise. Since the land's productivity has leveled off in recent years, there will be less food. There are 900 million more people to feed than ten years ago....putting a strain on food supply worldwide. Currently only 16% of our wages is spent for food. In many countries, food costs are over 50% of their income.

3. Agriculture occupies many types of land in Multnomah County. Are slopes or hillsides as fertile as the lower, flat lands?

Note: Many slopes in the area are very suitable for the orchards, vineyards, and nursery stock. This is partially due to the slope's likelihood to escape frost damage and develop warmer soil temperatures if on a southern exposure. These soils are generally not as fertile due to rainfall washing down valuable nutrients and increasing the acidity. Because of erosion problems, soils on hills cannot be cultivated to the extent needed for many lowland crops.

4. What are examples around your home and school which show an attempt to change the soil to meet our own needs?

Note: Addition of lime to reduce acidity.
Addition of gypsum to aid soil structure.
Addition of sand and humus to aid texture and water intake

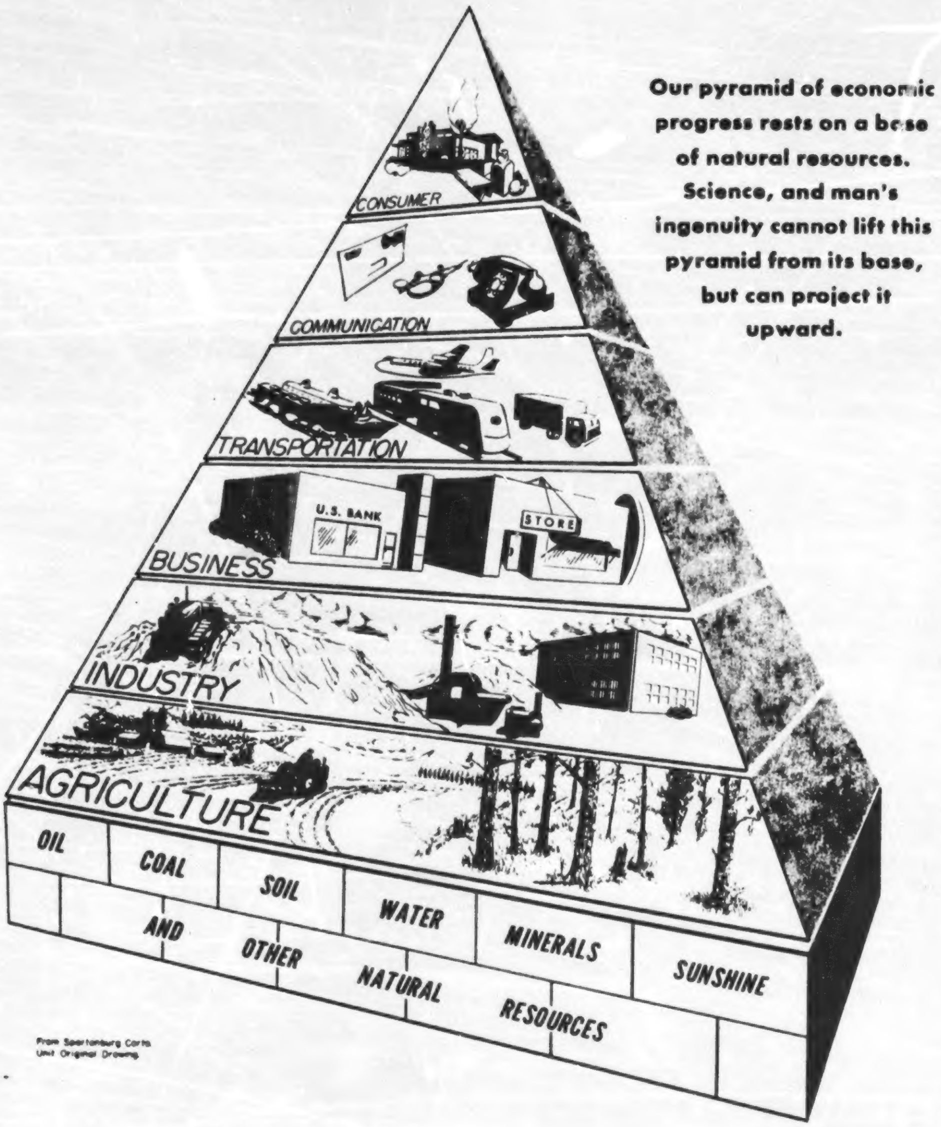
Addition of bark chips and other mulch to reduce plant competition and retain moisture and slow erosion.
Addition of nitrogen and minerals to increase fertility.
Addition of herbicides to reduce plant competition.
Addition of traps and poison to control moles, gophers, and other soil animals.
Addition of soil holding plants to slow erosion.

5. Is erosion always bad?

Note: Because we seem to accelerate erosion from poor land practices we sometimes overlook its other aspects. The formation of the Grand Canyon and river deltas are only two positive examples.

NATURAL RESOURCES

The base of our existence and the measure of our future


CONSUMER
COMMUNICATION
TRANSPORTATION
U.S. BANK
STORE
BUSINESS
INDUSTRY
AGRICULTURE
OIL
COAL
SOIL
WATER
MINERALS
SUNSHINE
AND
OTHER
NATURAL
RESOURCES

Our pyramid of economic progress rests on a base of natural resources. Science, and man's ingenuity cannot lift this pyramid from its base, but can project it upward.

From Spartanburg Corta
Unit Original Drawing

How is agriculture affected by the productivity of the soil? It is often overlooked that our urban industries and other businesses are also tied to the productivity of the land. How are some businesses directly connected to natural resources? How are others indirectly connected?

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

CONCEPT

Some minerals in the soil are used by plants. Water is necessary to make these minerals available to plants.

Soil nutrients are generally protected by undisturbed plant growth.

Time is the major factor when considering soil as a renewable resource.

AT OUTDOOR SCHOOL

Students realize that development of soil has taken millions of years. Over this time, weathering of different kinds of parent material has added minerals to the soil....many which are essential to plant growth. These essential minerals plus nitrogen (which is from the atmosphere) is continually increasing and decreasing through many processes. Rainfall, for example, adds nutrients, but it also continually washes nutrients away. Students see how nutrients may be taken from the soil for the growth of plants and animals, and later returned and accumulated in the topsoil when these organisms decay.

If given enough time in this natural system, at Outdoor School everything produced is "bio-degradable" and the soil is truly a renewable resource. Evidence of logged trees on the Outdoor School site is an example of a man-caused loss of soil nutrients through removal of the logs. However, in almost every case, the second and third growth of trees will have sufficient nutrients due to the slow natural addition of nutrients to the system and the relatively small amount of nutrients that are removed in the log portion of the tree. Time is again the key factor.

AFTER OUTDOOR SCHOOL

Even in our urban setting we can see soil nutrients being removed by way of grass catchers on lawn mowers and the harvesting of garden crops or flowers. Understanding the basics of the nutrient cycle in the natural system, your students can better understand how the removal of these crops may necessitate fertilizers and other amendments to the soil. Many plant growth experiments can be easily set up to show the effects of different kinds and amounts of nutrients.

Your students can also see that man has not only removed plants and animals from the land, but has transformed many of the land's elements into products that are either non-biodegradable or degrade very slowly. During an entire school year, projects can be undertaken to show various rates of decomposition. This can be an excellent spring-board for a lesson on energy and recycling.

LINKING OUTDOOR SCHOOL WITH THE HOME ENVIRONMENT

GOALS

Students should be learning that:

> Under the soil surface lie mineral resources which are essential in our urban lives.
>
> Man's need for minerals influences the amount removed from the land's parent material. Man's values and technology affect how the minerals are removed and the reclamation of the land.
>
> Essential minerals which are recycled continually through plants and animals are locked up in our man-made products.

KEY WORDS

Recycle
Reclamation
Surface Mining
Metallic Mineral
Non-metallic Mineral

MULTNOMAH COUNTY E.S.D. SOIL FILMS

Understanding Our Earth: Rocks and Minerals - Rev. #82885
Minerals And Rocks - #80785
Rocks And Minerals How We Identify Them - #81630
Food Energy From The Sun - #40242
There's No Away To Throw It - #21362
Urban Ecology Garbage Disposal - #41393

MINERAL RESOURCES IN OUR HOME AND SCHOOL

Mineral resources, unlike timber, generally go unnoticed as a major component of our urban environment. Since our life style is tied to the use of vast quantities of these natural resources, we are all responsible for their conservation.

Where are minerals used?

YOUR HOUSE COMES OUT OF A MINE

The raw material for the majority of the material used in building your home was furnished by the mining industry.

The foundation is probably concrete (limestone, clay, shale, gypsum, and aggregate mining).

The exterior walls may be made of brick (clay mining) or stone (dimension stone mining).

The insulation in the walls may be glass wool (silica, feldspar, and trona mining) or expanded vermiculite (vermiculite mining).

The interior walls are usually wallboard (gypsum mining).

The lumber in the structure will be fastened with nails and screws (iron ore mining and zinc mining).

If the roof is covered with asphalt shingles, the filler in the shingles is from a variety of colored silicate minerals from mining.

Your fireplace is probably of brick or stone, lined with a steel box (iron ore mining).

Your sewer piping is made of clay or iron pipe (clay mining or iron ore mining). Your water pipe is of iron ore or copper pipe (iron ore mining and copper mining).

Your electrical wiring is of copper or aluminum (copper mining or bauxite mining).

Your sanitary facilities are made of porcelain (clay mining).

Your plumbing fixtures are made of brass (copper and zinc mining), or stainless steel (nickel and chrome mining).

Your gutters of galvanized steel (iron ore mining and zinc mining).

The paint is manufactured with mineral fillers and pigments (from minerals obtained by mining).

Your windows are made of glass (trona, silica sand, and feldspar mining).

Your door knobs, locks, and hinges are of brass or steel (copper, zinc, and iron ore mining).

And finally, your mortgage is written on paper made from wood or cloth fibers, but fibers filled with clay (from clay mining).

- Wallace Miner, February 12, 1976

(From the "Ore Bin", February 1976)

Are there other minerals represented in the materials in your classroom?

Note: The list is almost endless. Consider for example, your pencil:

- flake graphite from Madagasgar or West Germany;
- clay as a graphite binder (the more clay, the harder the lead);
- brass for the eraser tip.

ADDITIONAL MINERAL BACKGROUND

Although the United States population is only 6% of the world population, we use ¼ of the world's production of minerals.

The United States also uses 1/3 of the world's energy. Much of this energy is used in the mining, transportation and processing minerals into useable products.

Approximately 2/3 of the material we use could be recycled.

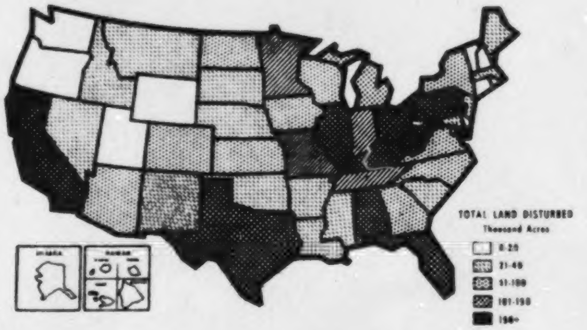
Americans throw away 70% of all metal after one use.

Recycling metal takes only 5% (average) of the energy as processing raw ore.

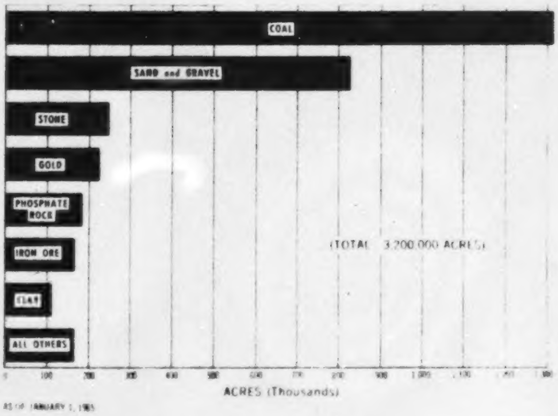
IMPACT ON THE LAND?

Surface mines (some of which are strip mines) are in every state in this nation. These mines, which produce over 50 minerals can cause severe impact on the land, wildlife, and waterways.

Reclamation, or restoring surface-mined lands, has lessened the impact on the environment. However, federal enforcement has recently (1981) been somewhat curtailed.



Surface-mined land—by States.



Surface-mined land—by commodities.

Oregon has relatively few acres of surfaced mined land due to the lack of coal, the number one surface mined product.

Sand and gravel production, some of which occurs locally, accounts for most of the 10,000 surface mined acres in Oregon. Of this land, approximately 7,000 acres require reclamation.

Nationally, over 4,000,000 acres have been surface mined. Half of this amount needs reclamation.

Over 11,000 miles of streams in the eastern United States have been affected by the mining of coal, lead, zinc, and manganese.

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METALLIC MINERALS

Oregon is the source of many metallic minerals which are part of our urban lives.

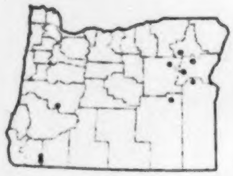
Good conservation practices must apply when using this natural resource since the supply is finite. It can be considered a renewable resource only if the mineral is recycled.

The United States is presently self-sufficient in copper, molybdenum, magnesium, lithium, barite, iron, lead, and zinc.

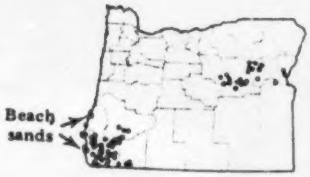
Imports provide more than 2/3 of the supply of aluminum (bauxite), fluorite, nickel, tungsten, and tin.

Although our main concern is focused on the supply of "fuel minerals", the supply of many non-fuel minerals are essential for our future energy independence.

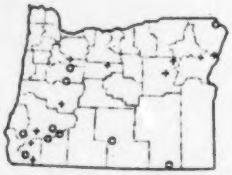
There are more than 90 mineral commodities used in this country. During the next fifteen years, it will take over 18 billion barrels of oil-equivalent to produce only 20 of these minerals.



ANTIMONY

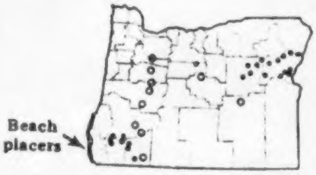


CHROMIUM



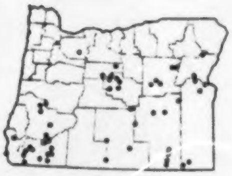
COPPER, LEAD AND ZINC

+ Major mines
○ Prospect areas

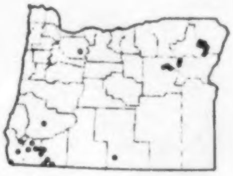


GOLD AND SILVER

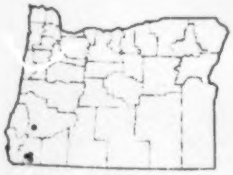
● Major mines
○ Minor mines



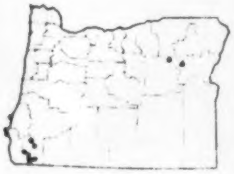
MERCURY



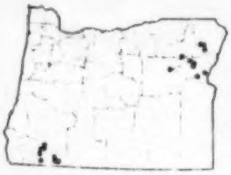
MOLYBDENUM



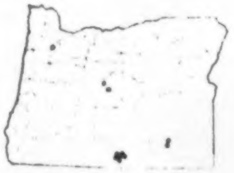
NICKEL



PLATINUM



TUNGSTEN



URANIUM

Sources: The mineral maps shown above are abstracted from Mineral and Water Resources of Oregon, 1969 report United States Geological Survey.

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NON-METALLIC MINERALS

In Oregon 66% of the state's $81.5 million mineral production value is from sand, gravel, and stone.

The amount of non-metallic mineral resources used in the United States in 1973, if divided among every man, woman, and child, would show a per capita "use" of:

Sand and gravel	9,000 pounds
Stone	8,500 pounds
Cement	800 pounds
Clay	600 pounds
Salt	450 pounds
Other non-metals	1,200 pounds

Obviously, each person directly uses only a small fraction of this amount. However, this amount is used as a critical raw material to maintain our industry. Non-metallics also provide the raw materials for our homes, schools, roads, bridges, airports, etc.

In 1974, the total value of all metallic mineral resources produced in the United States (including gold, silver, copper, lead, zinc, manganese, etc.) totaled $3.5 billion, but the combined value of all non-metallic categories (stone, cement, sand, and gravel) had a $4.2 billion value.

The most common element of soil and rock is called silicon. This element when bound with oxygen (silica) forms sand.

Silica, and only three other elements, aluminum, iron, and calcium, provide the basic building blocks of the earth. Together they form 9/10 of our planet's surface.

AN EXAMPLE OF VOLUME

A deposit of sand and gravel 27 feet deep underlying one acre of land will produce 43,560 cubic yards of useful material. This material, after being crushed, sized, screened, and washed could sell for $9.00 per "yard".

DISCUSSION QUESTIONS OR ACTIVITIES

Why is it important for each of us to understand what minerals are in the products we use in our daily lives?

> Note: Every time we choose to use a product made up of a non-renewable natural resource, we have an impact on the land and on future generations. Also, to maintain our standard of living, we import large quantities of minerals which create a dependance on other countries.

What can be done to cause less impact on the land?

> Note: Waste less, recycle more, and support reclamation of mining lands. Finding areas for more and larger solid waste landfills is a major problem locally. Good conservation practices can lessen this need.

Locally, what is the most valuable mineral resource?

> Note: Portland is on top of a massive gravel resource. This can be a beginning place for understanding Oregon geology.

What are examples of metallic and non-metallic minerals in your classroom?

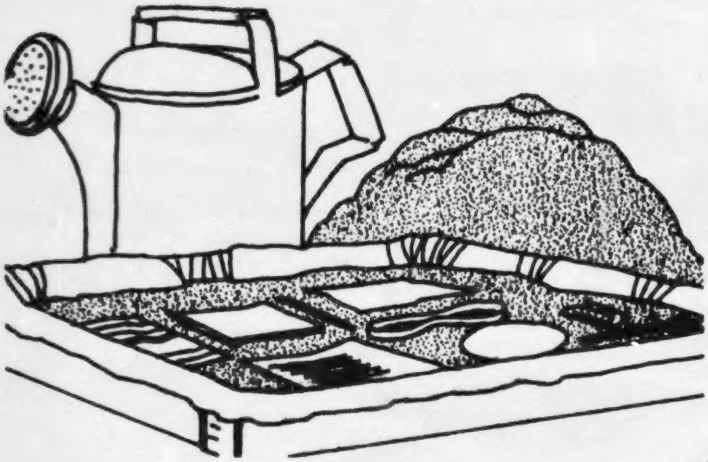
> Note: The list can be lengthened. For example, each color of paint on the school may represent different minerals. Many early paints indicated their minerals in the label, such as cobalt blue, zinc white, and cadmium yellow.

Compare mineral use in the United States with use in other countries. Why is conservation especially important in the United States?

> Note: Since we use more minerals than other countries, we have much more to loose by shortages, embargos, etc.

A popular packaged dog food includes the following mineral assay: calcium, phosphorus, potassium, magnesium, sodium chloride, sulfur, manganese, iron, copper, zinc, cobalt, iodine, and selenium. If these minerals are essential, where did the dog's early ancestors get these minerals?

> Note: Being carnivores, they ate animals who ate plants which contained these minerals. These minerals were taken from the soil by plants and many (cobalt, for example, is needed by animals, but not plants) are also essential for plant growth.



The solid waste explosion in this country has reached a level of 413 billion tons per year! What impact does this have on our mineral resources?

Note: Minerals are "locked up" in all products. Many products (e.g. food) degrades very quickly under correct conditions and other products would not change noticeably in our lifetime. The "bury it and dig it up later experiment" demonstrates this. For example, several groups of products including aluminum foil, tin can lids, newspaper, rubber bands, leather, wool, cotton, nylon, toothpicks, etc. can be buried in soil. Moisture, temperature, soil depth, organic matter, and other factors can be varied on each group of products. Over a period of months, observations and conclusions can be drawn. What minerals are represented in the decomposing products? What minerals are essential to plants? Animals?

FINDING SOLUTIONS TO ENVIRONMENTAL PROBLEMS

Students returning from Outdoor School will not only have a better understanding of our natural system, but will also have a foundation for understanding the changes going on around them in their home environment. Students see orderly, predictable changes occurring in the natural environment, but around their home fast growth or development may be an accepted everyday occurrence. Bridges, housing developments, parking lots, new highway projects and other changes may appear to questioning observers to threaten "quality of life" rather than improve it. To find the correct answers and solve the problem, one must ask the right questions.

Below are thirty questions which are commonly used to measure environmental impact on a sophisticated and professional level. At the elementary level this set of questions can be adapted for use. The questions marked with an asterisk are ones dealing with Outdoor School concepts. *

It is important that students at the elementary level realize they probably cannot make experienced judgements about the complex problems of land use... many which span economic, political, and ecological aspects. However, they can understand how environmental concepts are used to solve complex urban problems and the importance of gathering facts before making decisions or judgements.

In determining a project's environmental impact, some of the questions which should be considered are:

1. Will there be a change in air quality during and/or after construction?

* 2. Will there be a change in water quality during and/or after construction?

* 3. Will there be any change in the water table as a result of the project?

* 4. How will excess excavated materials be disposed of?

* 5. How will the land structure be changed (e.g. ground cover and contour from grading, channelization, drainage of swamps, changes in natural drainage systems)?

6. Will crop or grazing land be affected by the project?

7. Will the level of noise change during and/or after construction?

* 8. Will there be an aesthetic (visual) deterioration as a result of the project or any odors?

* 9. Will any nonrenewable resources or mineral deposits (such as coal or uranium) be affected?

*10. How will the diversity and density of animal and plant populations be affected?

11. Will the project interfere with animal migration routes?

*12. Will any foreign or domestic animal or plant species be introduced into the project area?

*13. Will any rare or endangered species be affected by the project?

14. Will any historic or archaeological features, unique wildernesses, or natural areas be affected by the project?

*15. What changes will occur to recreational lands and wildlife habitat?

16. Will the project ultimately change the amount of energy entering the earth's atmosphere through a given wave spectrum? For instance, change the ozone layer and ultraviolet light?

*17. Will the project result in changes in climate, weather, temperature, or wind patterns?

18. Will the project affect plant populations to the extent that there is a reduction in atmospheric oxygen supplies?

19. How will possible contaminants (radioactive wastes, solid wastes, chemicals) be transported, stored, and disposed of after construction?

20. Will the functions of the project have the potential of changing the genetic code of animals?

21. What changes in human population density will occur during and after construction in the project area?

22. How will education (e.g. school enrollments, programs, teaching needs, and health services) be changed as a result of the project?

23. How will transportation systems and services in the project area be changed during and after construction?

24. Will the project result in the construction of small businesses in the area which could have a significant effect (either positive or negative) on the environment?

25. What will be the number and types of new jobs available during and after construction?

26. What changes will occur to the overall economic status of the area; consider income, taxes, cost of electricity, products, and services.

27. What provisions have been made for adequate security, police, and fire protection?

28. What provisions have been made to ensure the public protection against natural hazards which could be associated with the project from earthquakes, tornadoes, flooding, sinking, or settling of the earth under foundations?

29. Are there any earthquake or geological faults on or near the project site?

30. What legislation applies to the project at the national, state, and local levels? Which laws are being adhered to or enforced? Will there be a need to change pollution standards or regulations or zoning ordinances?

LIST: From "Finding Solutions To Environmental Problems"

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